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THE ENGINEER

JANUARY 1, 1954

Locomotive Builder's Jubilee

To mark the occasion of the fiftieth anniversary of its foundation the North British Locomotive Company, Ltd., has published an interesting book giving a concise account of its history. This well-known firm of locomotive designers and builders was formed in 1903 by the amalgamation of three firms of locomotive manufacturers with works in Glasgow—Neilson, Reid and Co., Dübs and Co., and Sharp, Stewart and Co., Ltd. The history of each of these three firms given in the book shows that the oldest was Sharp, Stewart and Co., Ltd., the origin of which is traced back to a concern known as Sharp Greenleaves and Co., started in Manchester in 1811. In later years it became successively Sharp Roberts and Co., Sharp Brothers, and in 1852 Sharp Stewart and Co., when it was joined by Charles Patrick Stewart. The first locomotive, the "Experiment," was built by the company in 1833, and during the years that followed a number of engines were built for railways at home and abroad. In 1888 the firm moved to Glasgow, when it acquired the Clyde Locomotive Company, Ltd. The early history of Neilson, Reid and Co., the largest concern at the time of the amalgamation, is somewhat obscure, but it is stated that its Hydepark works were founded by Walter Montgomerie Neilson in 1836. This firm, which first started to build locomotives in 1843, changed its name a number of times, becoming Kerr Mitchell and Neilson in 1840, Neilson and Mitchell in 1845, Neilson and Co. in 1855, and Neilson Reid and Co. in 1898. Dübs and Co. was started in 1863 by Henry Dübs, when he severed his connection as a managing partner with Neilson and Co. As every student of locomotive history knows, each of these firms was responsible for a number of famous old locomotives, and when in 1903 their knowledge and resources were combined, the success of the newly formed company was never in doubt. The North British Locomotive Company, Ltd., and its constituent companies have in the past 120 years been responsible for building no less than 28,000 locomotives for the railways of this country and overseas.

Enterprise in Shipbuilding

SPEAKING after a recent launch, the chairman of the Furness Shipbuilding Company, Ltd., Mr. Charles Clore, had something to say about the full use of resources and maintained that failure would be the inevitable result where the continuation of the *status quo* was the rule and where enterprise was considered to be speculation. He instanced the ship just launched as an example of the full use of resources whereby certain otherwise fixed assets were being profitably employed and put to the most advantageous economic use. It was impossible, he said, to hold back the forces of progress and linked the standard of living of this country with the degree of profitable use made of its assets. The resources of this country could not be left to stagnate and he stated that the company which fully employed its resources was acting in the general interests of all concerned by ensuring full employment and by increasing earnings and dividends so that the overall national prosperity was improved. Mr. Clore went on to discuss the matter of the difficulties in obtaining credit and thought that the recent announcement regarding the relaxation of controls had come much too late. On this question of shipping finance he felt certain that had this problem been boldly tackled at an earlier date, Great Britain would have owned a bigger part of the independent world tanker fleet and of its considerable earning power than it actually did. Mr. Clore advocated the sweeping away of controls and restrictions to give place to the operation of a free economy where enterprise was encouraged and not decried. We must not, he continued, remain static and bemoan the severity of foreign competition but be prepared to move forward and hold our position by means of enterprise, improved efficiency and hard work.

British Iron and Steel Federation

THE British Iron and Steel Federation has announced that Mr. G. H. Latham has been elected president, in succession to Sir Ellis Hunter. Mr. Latham, who has held a prominent position in the British iron and steel industry for many years, is the chairman and managing director of the Whitehead Iron and Steel Company, Ltd. He is chairman of the executive, management and standing committees of the National Association for Rolled and Re-rolled Steel Products. Mr. Latham also serves as technical adviser for the steel industry to the Finance Corporation for Industry, Ltd., and from 1946 to 1949 was a member of the first Iron and Steel Board. In addition, he has served as president of the British Iron and Steel Research Association. He became a member of the Iron and Steel Institute in 1936 and was elected a vice-president in 1946. The president-elect of the British Iron and Steel Federation is Mr. A. G. Stewart, chairman and general managing director of Stewarts and Lloyds, Ltd. Mr. Stewart joined his firm in 1924 and was appointed managing director in 1931. In addition, he is chairman of the Stanton Ironworks Company, Ltd.

National Research Development Corporation

THE annual report of the National Research Development Corporation for the year ended June 30, 1953, states that its borrowing powers cease at the end of June, 1954, and if it is to continue further powers for borrowing, entailing legislation, will need to be effected before that date. As this report is, therefore, the last which will appear before such legislation a more extended account is given of the Corporation's financial and trading prospects than has been attempted hitherto. It is pointed out that the main task of the Corporation during its first four years has been to administer and to secure the exploitation of public inventions. As a result of four years' working the Corporation is a party to more than 250 licence agreements with industry in this country or abroad, and to revenue sharing agreements entered into with universities, university research workers and industrial research associations. This work involves the administration of 2224 patents and patent applications in the United Kingdom and overseas. A table giving expenses and receipts shows that during the year under review the fixed and semi-fixed charges amounted to £90,086 and the variable charges £30,704; whilst the recurrent and non-recurrent receipts were £21,204 and £2129 respectively. In a section of the report dealing with development projects it is pointed out that electronic digital computers continued to represent the Corporation's largest single commitment. Work on four large machines which have been commissioned by the Corporation was well advanced by the end of the year and commercial orders had been received for three of them. The report goes on to record that continued support was also given to the work on hydro carbon synthesis at the Imperial College of Science and Technology. In addition, a contract was placed with the Reading University for the construction of a prototype machine for the liquefaction of atmospheric gases. This machine, which was invented at the university, is of much smaller design than the machines of its kind at present available.

Mr. W. E. Benbow

WE have learned with regret of the death of Mr. William Edwin Benbow, which occurred, suddenly, in London, on Tuesday last, December 29th. Mr. Benbow was particularly well known in the iron and steel and foundry industries, having been editor for some years of our contemporary, *Iron and Steel*. He was born in 1900 and began his technical career in 1917 in the metallurgical laboratories of Vickers, Ltd., Crayford. Subsequently, Mr. Benbow became assistant to the chief draughtsman of Hooper and Co., Ltd., which was at that time engaged on aircraft production. In 1921, he joined the staff of J. and E. Hall, Ltd., Dartford, as assistant to the works chemist and metallurgist. There he was largely concerned with foundry control, the routine control of engineering materials and the investigation of metallurgical problems associated with refrigeration. Mr. Benbow took up technical journalism in 1929, when he was appointed assistant editor of *Metal Industry* and *Iron and Steel Industry* (now *Iron and Steel*), and a little later he became the first editor of *Welding and Metals Fabrication*. He succeeded the late Mr. L. P. Sidney as editor of *Iron and Steel* in 1935. Other work for which Mr. Benbow was responsible in recent years included the editing of a book entitled *Steels in Modern Industry* to which twenty-nine specialist authors contributed. Mr. Benbow was elected a member of the Iron and Steel Institute in 1936.

Mr. J. E. Hodgkin

IT is with regret that we have to record the death of Mr. Jonathan Edward Hodgkin, on Saturday last, December 26th, at his home at Bishop Auckland. Mr. Hodgkin was born at Darlington on November 4, 1875, and following his education at Bootham School, York, and Leighton Park School, Reading, he was apprenticed as an electrical engineer with Ernest Scott and Mountain, Ltd., of Newcastle on Tyne. Shortly after completing his apprenticeship he started business on his own account and during his subsequent career in industry was connected in an administrative capacity with more than twenty public and private companies. For thirty-five years he was associated with the Motor Union Insurance Company. He was chairman of Darlington Wire Mills, Ltd., and served on the boards of a number of other firms associated with the engineering industry. Mr. Hodgkin was also a noted archæologist and played an important part in the formation of the Pierce Bridge Excavation Committee and in the excavation of the British Camp at Hamsterley. He was a member of the Institution of Electrical Engineers and a member of the Institution of Mining Engineers.

Civil Engineering in 1953

No. I

NINETEEN FIFTY-THREE will be remembered by civil engineers as the year of the great storm and tidal surge in the North Sea. All along the East Coast of England, from Yorkshire to Kent, major constructional works were in progress to restore the damaged sea defences. Emergency works were in hand immediately after the disaster, which occurred on the night of January 31st and February 1st, and permanent reconstruction and improvement was started a few weeks later. Legislation was enacted in Parliament to give the river boards greater powers to carry out these works without delay. A large constructional programme was soon undertaken, for which the completion date was ambitiously stipulated for September. Generally, this target was reached, but some of the river boards allowed longer periods for the completion of various major works, with constructional programmes extending into this year.

Apart from the exceptional effort made on the East Coast, the year lacked major events ; no civil engineering scheme of the first magnitude was opened in this country during the year. The schemes inaugurated—their size may be gauged from the fact that generally each of them cost less than £1,000,000 to complete—included the flood alleviation channel by-passing Spalding on the River Welland ; two important water supply reservoirs, Digley reservoir for the Huddersfield Corporation, and Blithfield reservoir for the South Staffordshire Waterworks Company (the progress of both these schemes was recorded in our annual civil engineering review of January, 1952) ; St. Clements bridge, an aluminium bascule structure of advanced design, at Aberdeen, and the car ferry terminal at Dover. Civil engineering activity was again hampered by restrictions on capital works, and schemes were still being deferred or retarded for this reason in 1953. There were signs, however, of some improvement, but the general position showed little difference from previous years, except in the case of the East Coast sea defence works.

Improvements in the design and construction of civil engineering works take place continuously, and various examples of new trends and achievements will be found in the succeeding parts of this article. Such advances may take several years in their development to perfection, and are more evident over a longer period than is covered by this review ; over, say, five years, the changes in practice may be outstanding, as they have been in several branches of civil engineering in this country in the past five years. But even in one year appreciable progress can be made, and 1953 was not without its contribution of new ideas and innovations, in spite of the absence of any considerable constructional progress in some branches of the industry.

The East Coast Floods

Only a brief survey of the 1953 East Coast sea defence works can be given here. A more detailed account was published in THE ENGINEER of December 4th, 11th and 18th last ; a two-day conference was held at the Institution of Civil Engineers on December 16th and 17th, when twelve papers, covering all the various technical aspects of last January's disaster, were presented for discussion. In fact, the events of last January brought about a renaissance in the interest shown in coastal problems. As one of the authors at the conference remarked, the problem was dealt with for the first time on a national basis, and some monumental works were built at a rate of output only equalled once before, namely, in the days of the "Mulberry" harbours. Civil engineering works of reinstatement and improvement will have accounted for an expenditure of £14,000,000 by the end of the financial year, it was estimated (the entire programme of works totals very approximately £20,000,000). It should be borne in mind that these works were undertaken without a lengthy period for design and negotiation; works which are built very quickly generally take a correspondingly longer time at the drawing-board stage, but such was not the case last year on the East Coast. But with the spirit of emergency prevailing, contract negotiations which normally take many weeks, another author noted, were carried through in as many days. It was to have been expected that with these conditions, the resulting sea defence works would be of conservative, well-tried design, and would make use of readily available materials and plant ; it could not have been otherwise. Nevertheless, there is much technical interest in the new works, and, taken as a whole, they incorporated a surprising number of refinements of design and execution, to suit the various local conditions encountered.

From the recent two days of discussion at the "Civils," however, it was evident that there is still much to be learnt in the design of these works. One speaker remarked on the few occasions when figures were quoted in the discussion, for, he contended, unless an analysis could be expressed in numbers it was probably not worth a great deal. There is still too little quantitative knowledge for the rational design of coast protection works, and basic data are urgently needed, on the behaviour of waves, for instance, and the forces they exert on a sea wall ; the design of groynes is, similarly, not yet by any means an application of scientific principles. But these are long-term considerations, and 1953 was a year of hasty action and achievement for the coast protection engineer.

The clay embankment forms a fundamental part of the coast protection along substantial lengths of the East Coast. This seemingly primitive and uninteresting "structure" becomes, on closer inspection, worthy of lengthy and complicated discussion, and presents awkward problems requiring considerable engineering skill in their solution. First, there is the soil mechanics aspect. Many of the banks were built in areas where the marsh consists of a moderately stiff crust of clay, with much weaker material below it, and it is difficult to build to the required height. Second, there is the effect of the sea on the bank. The modes of failure were given by Cooling and Marsland as (*a*) erosion of the seaward face by wave action, (*b*) erosion of the landward face following overtopping, (*c*) slipping or slumping of the landward face caused by seepage through the bank, and (*d*) building up of water pressure in pervious layers underlying the bank, leading to complete failure.

There was a tendency to rebuild the embankments to more substantial dimensions than before, with broader crests and flatter slopes. Where it was difficult to reach the

Fig. 1—Embankment Construction at Canvey Island

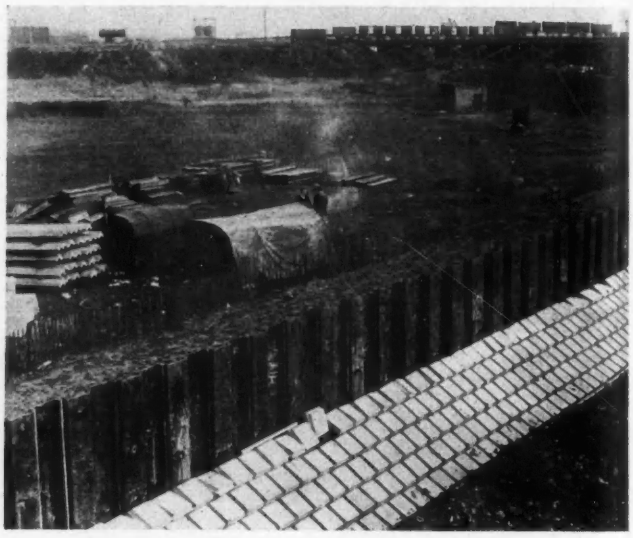


Fig. 2—Construction of Embankment with Sheet-piled Parapet at Purfleet

desired crest height, a concrete or steel sheet piled crest wall was often added. In exposed places, precast concrete blocks were used to revet the seaward face. A substantial embankment with such a facing, which in this case was laid inside a grillage of reinforced concrete beams capped with a bullnosed wave wall, is shown on Plate 8. This wall is at Graveney, and was built under the direction of the chief engineer of the Kent River Board. The precast blocks are each 15in by 15in by 8in in size, with stepped edges ; interlocked joints were thus formed, which were left unsealed. A typical embankment in one of the less exposed situations is shown under construction in Fig. 1 ; Fig. 2 shows a steel sheet-piled parapet wall which effectively heightens the embankment on which it is built. Both of these works were built under the direction of the Essex River Board's chief engineer. The steel sheet piled parapet was used fairly extensively in Essex. The facing blocks in this case are the same size as for the Graveney wall, but they do not have interlocking joints and the joints were grouted with filled bitumen to give an impermeable crest on the seaward side. A trial length of embankment was built by the Essex River Board, to a lower height than the general standard, on the south side of the River Crouch. In addition to the normal revetment, the crest and back slope were surfaced with asphalt, and it is thought that the bank will be able to withstand occasional overtopping from an exceptional tide.

Three typical designs of sea wall in Lincolnshire are shown in Fig. 3. The clay embankment was also utilised extensively on the Lincolnshire coast, and the upper cross section shows the slag-pitched revetment on the seaward face of banks in the more exposed situations. The stepped reinforced concrete wall shown in Fig. 3 is situated near Skegness ; a similar, but not identical design is shown under construction inside a cofferdam on Plate 8. The lower cross section in Fig. 3 shows a wall faced with large bitumen-jointed precast blocks, which form a surface flexible enough to take up a certain amount of movement due to settlement of the embankment. This wall was designed by Wilton and Bell, and C. H. Dobbie acting as joint consultants, and the other two walls shown in Fig. 3 were built under the direction of the chief engineer of the Lincolnshire River Board.

A sea wall on the Norfolk coast is shown in Fig. 4. It is a reinforced concrete stepped structure, with steel sheet piling forming a cut-off at the toe, and it extends for 12,500ft along the coast at Sea Palling. A rather elaborate installation of constructional plant was employed for its construction, to achieve rates of progress in excess of 100ft of wall per day, and the contractor, John Laing and Sons, Ltd., ran concrete trucks along the sand foreshore in front of the wall, keeping an improvised road passable by the use of a water lorry, to keep the sand wet and firm, trailing a small grader blade which continuously filled in the ruts caused by the traffic. This wall was designed by the consulting engineers, Messrs. Lewis and Duvivier, for the East Suffolk and Norfolk River Board.

The sea wall at Kessingland, shown on Plate 8, was built to protect a cliff of poor material, and consists of a steel sheet piled cut-off in front of a reinforced concrete promenade which acts as a slab of low bearing capacity ; there is a wave wall on the landward side of the promenade, with a sloping reinforced concrete slab above it up to a top level of +20 O.D., and a shingle drain is provided behind the wave wall. The permeable steel groynes built with this wall, which have been successful in accumulating several feet of beach, may be noted in this illustration. In less frequented areas where similar unstable cliffs were encountered, permeable revetments, as illustrated on Plate 8, were built in conjunction with the permeable groynes. The revetments consist of a framework of either steel or timber, filled with random lumps of concrete. These works were designed by Mr. S. W. Mobbs, the consulting engineer, for a number of coastal rural district councils in Norfolk and Suffolk.

It has not been possible to mention in this brief review of a vast undertaking, the names of all the river boards and firms which played an important part, but a complete list was given in our earlier article to which reference has already been made. As a last example of sea defence works in 1953, some details of a sea wall on the South Coast near Folkestone are now given.

Over a period of years, largely due, it is thought, to the fact that the groynes over the stretch of coast at Sandgate, had, in the main, not been properly maintained, the level of the beach had fallen to a dangerous extent, exposing the poor foundation of the existing wall and the action of the sea had resulted in the sucking out of the backfill and the collapse of the wall at the weakest points. The first stage towards the rehabilitation of the coast was the construction of seventeen groynes under the superintendence of the borough engineer.

The old sea wall at Sandgate has a length of 3500ft, and the toe coincided approximately with high water of spring tides and consisted essentially of a masonry facing backed by a lime concrete, which had deteriorated in quality and lacked cohesion. Generally, the existing wall was not fulfilling its function as a retaining wall, having practically no foundation and little cohesion in the backing and was, therefore, unable to withstand the battering of the seas during gales.

The existing wall was utilised in part for the new works by the construction of a screen wall set sufficiently far in front of it to enable the steel sheet piled cut-off under the toe of the new wall to be driven clear of the accumulations of rubble from broken foundations and parts of fallen walling. The coping level of the new wall is some 6ft above high spring tide level and 7½ft below the top of the old wall. The space between the two walls was filled with beach material and surfaced with a reinforced concrete slab which forms a continuous gangway for maintenance and for access to the beach. The new sea wall is illustrated in Fig. 5 ; it is constructed of mass concrete (5 to 1), faced with precast blocks, and has a battered face and bullnose coping. The toe is protected by steel sheet piling 12ft 6in in length. The precast blocks forming the facing are

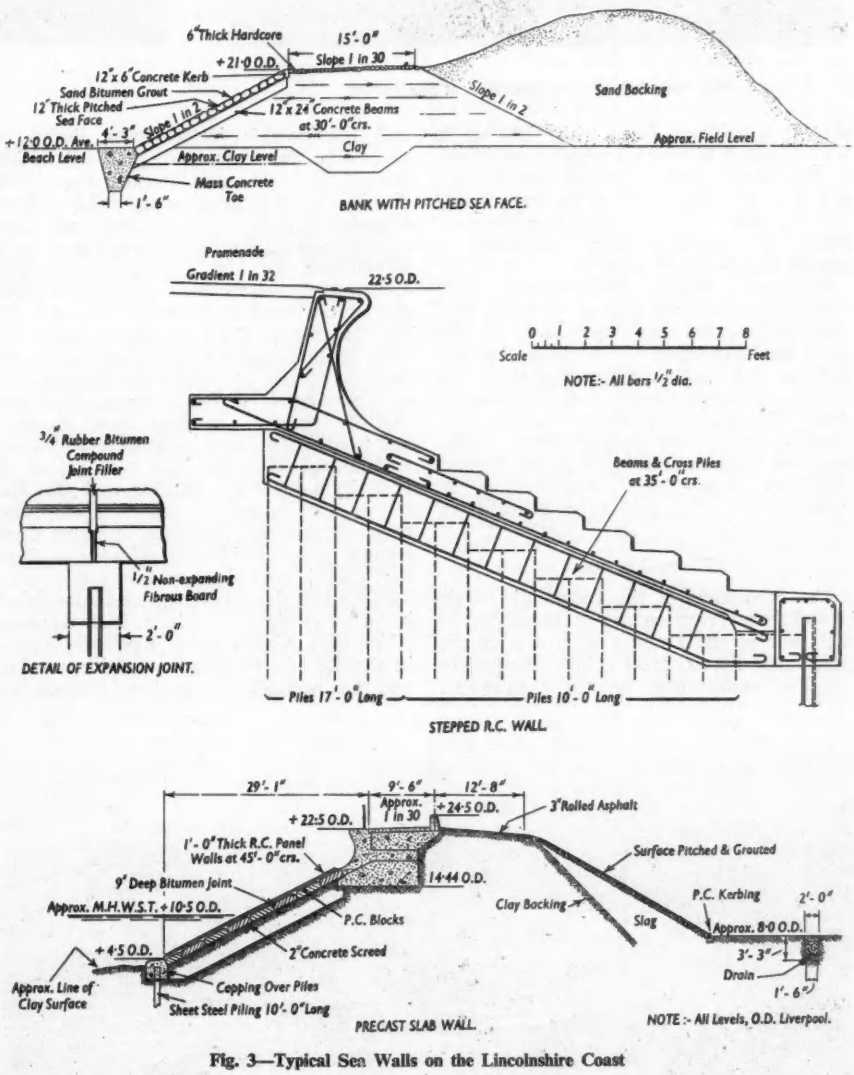


Fig. 3—Typical Sea Walls on the Lincolnshire Coast

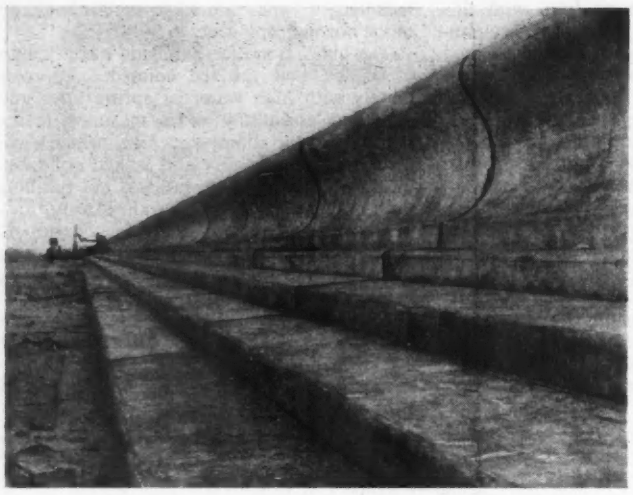


Fig. 4—Reinforced Concrete Wall at Sea Palling

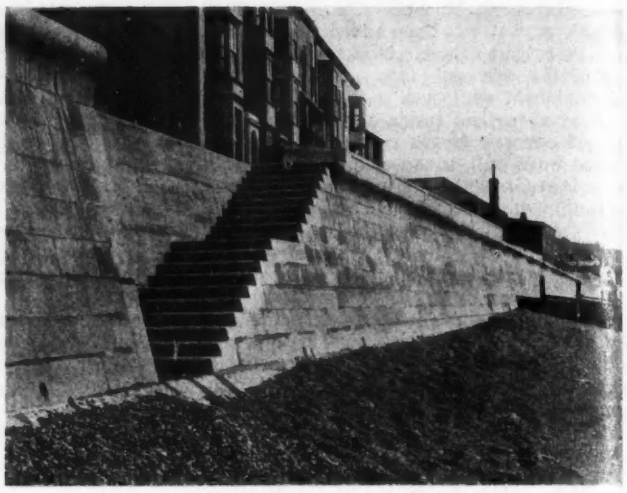


Fig. 5—Sea Wall at Folkestone

of 4 to 1 concrete faced with flints set in 2 to 1 mortar in which a proportion of salferricite was mixed to offset the abrasive action of the shingle. The bullnose coping is faced with 2 to 1 granolithic concrete. Three boat slipways were constructed as well as four flights of steps.

The new sea wall work was carried out by contract by the Demolition and Construction Company, under the supervision of the consulting engineers, Sir William Halcrow and Partners, and was completed in sixteen months, or some six weeks under the contract time. Included in the works was the construction of one new groyne and the reconstruction of four other groynes at Radnor Cliff, work which was carried out by R. Robinson and Co., Ltd., as an extension of the earlier groyne contract.

River Floods

The occurrence of the Lynmouth floods in 1952, the inversion fog of December of that year in the London area, and of the East Coast floods, drew public attention to all these unfortunate natural phenomena, and considerable interest was shown in proposals for their study and alleviation during 1953. The public health engineering division of the Institution of Civil Engineers organised a lecture on atmospheric pollution last November, a subject which has no little significance for the civil engineer. The Lynmouth floods were the subject of a paper reproduced in THE ENGINEER of June 5th last, but it is to the more general aspect of river flooding that we wish to refer now. In leading articles in *Nature* for August 15th and November 7th last, it was pointed out that the reaction to these three disasters had been rather inconsistent in several ways. Committees of inquiry had been set up to investigate the tidal flooding and the fog, but no such committee had been appointed to investigate river flooding, although there seemed to be considerable evidence to show that such a committee was very necessary. Two kinds of river flooding were distinguished in *Nature's* articles, namely, periodic flooding, which was related to a repetitive régime in the life of a river and was fairly regular, and thus normally expected and catered for, and episodic flooding, such as occurred at Lynmouth, which was related to abnormally heavy storms, and occurred infrequently in any one locality. However, the infrequency of episodic flooding in any one locality tended to mark the general picture, *Nature* contended, and at the time of the second article, "exceptional and potentially dangerous" falls of rain (i.e. 2in to 3in in a day) had been revealed from official records on sixty to seventy occasions since the Lynmouth disaster. The articles went on to point out that more knowledge was needed on this subject, not only to avoid damage, but because of the increasing utilisation of the country's water resources, which were not by any means inexhaustible under present-day conditions.

As we have noted, "periodic" flooding is expected and allowed for in many river catchments. Flood protection forms a very important part of the life of the fens of Lincolnshire, and a major element in a flood protection scheme in the fens—the Spalding by-pass channel—was opened last September. Flood protection on the River Welland was governed by the passage of the river, in a rather restricted channel, through the built-up area of Spalding. So as to avoid interference with the town, a flood alleviation channel, which forms the basic element of a comprehensive scheme of flood protection on the Welland, was built in a U-shape, round the town, for a length of about 2 miles. Part of the completed channel is shown in Fig. 6. The channel is closed by sluice gates at each end and there are eight bridges across it at various points; it has a bottom width of about 100ft, with extensive berms and embankments forming the channel itself. It was designed by the Welland River Board, and cost about £500,000 to construct. A further account of this channel and its significance in relation to flood protection on the Welland will be given in a future article.

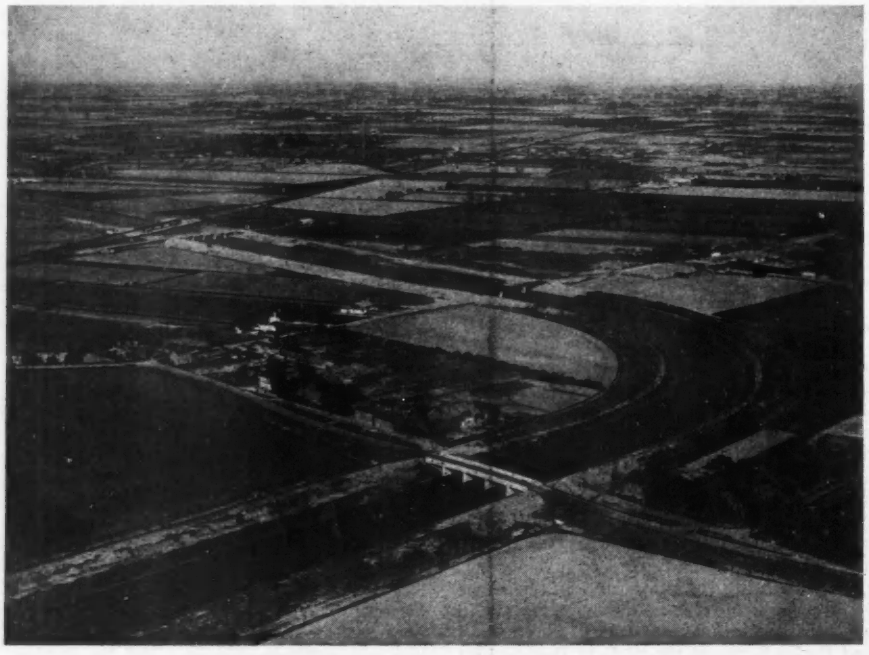


Fig. 6—The Spalding Flood Alleviation Channel

The Preparation of Structural Steel

A development which, although primarily of a mechanical engineering nature, is of much interest to civil engineers, particularly those concerned with structural steelwork, is illustrated in Plate 5, where a plant for the preparation of rolled steel sections for structural work may be seen. We have included a brief description of this plant here, but a full description was given in THE ENGINEER of June 19th last.

The accepted practice for producing the component units in a structural steel works

has for long been to make templates of each of the members from detail drawings and use these templates to mark off the holes, notches, &c., on sections cut to length. Drilling, notching, &c., is then done on individual machines and the bars or sections sent on to the assembly lines. Between the stockyards, the marking-off and the machining processes, the sections have to be moved by cranes or trucks and much heavy handling is involved.

With the plant installed last year at the Norwich works of Boulton and Paul, Ltd., and the system evolved for its use, template making and the marking-off of sections in the works has been completely eliminated, actual machining time has been reduced substantially and lifting and transport of the sections between operations is no longer necessary. Drawings are not required in the workshop until the assembly stage is reached, but a special form or job-chart is prepared from the drawing, and the forms are issued to the stockyard in the correct order and the work follows through the plant in the same sequence.

The plant is designed to handle all structural steel sections up to 27in by 12in by 55ft long, and its general layout can be seen in Plate 5. It consists essentially of roller conveyors and feed benches between a vertical cold saw—to be seen in the left background of the illustration—a horizontal drilling machine—midway along the plant on the right-hand side—and a vertical drilling machine in the left foreground. The stockyard is on the right-hand side of the plant at the far end of the shop. The operations of sawing and drilling are fully mechanised, and there is automatic length measuring equipment at each stage for the positioning of the section which is being prepared.

(*To be continued*)

Atomic Energy in 1953

THE most striking aspects of the past year were the success achieved in the pioneer scheme for a breeding reactor, and the several claims put forward for the successful construction of experimental hydrogen bombs by the use of some form of thermo-nuclear reaction. Whether the American tests of November, 1952, at the Eniwetok Atoll in the Pacific included actual thermo-nuclear explosives has not been definitely revealed, but it seems exceedingly likely. Nor do we know much more as to the basis for the U.S.S.R. claim for success in this same direction in August last. The American claim was not very precisely worded: officially it was merely that the tests "included experiments contributing to thermo-nuclear weapons research," but almost as much was claimed for the Eniwetok tests of May, 1951. So how long a start the U.S.A. has over the U.S.S.R. in this particular field is therefore unknown; but it may well be as much as two or three years. In any case the lead of America in the production of the uranium variety is a material factor since it appears that for the hydrogen bomb a temperature running into millions of degrees is required and it seems likely that each hydrogen bomb will require some fissile uranium to act as detonator: that this might prove to be so was a striking forecast in Professor Gamow's *Atomic Energy*, published as long ago as 1946.

The Minister of Supply announced in the House of Commons in June last that there would be carried out later in the year some further Anglo-Australian tests in a suitable area on the Woomera rocket range in connection with the development of atomic weapons needed to meet various service requirements; and that in carrying them out every precaution would be taken to avoid the risk of contamination of inhabited areas and grazing land. The programme of the first of these highly secret tests included an atomic weapon detonated on a 200ft tower, another at ground level, and a third released from a Canberra jet bomber. The second series of tests, which took place in October, was stated by Sir William Penney in his report to the Minister of Supply to have as its object the obtaining of important scientific information needed for the weapons development programme. This called for trials involving a number of what were termed "minor explosions" to complete the programme of experiments as planned. These brought the present series of tests to "a successful end"—but the conclusions reached were, of course, secret and not released in any form for publication.

Breeding Reactors

Two main difficulties have hitherto stood in the way of the production of power for civil use: the fear lest the general possession of fissile material should, in the absence of effective international control, afford an opportunity for disaffected peoples to divert its use to warlike ends; and the inadequacy of the naturally occurring supplies of the fissile isotope (235) of uranium. The first obstacle still exists, unfortunately, for there seems to be little prospect of an improvement in the political position, except perhaps through the U.S. President's idea of a pool of fissile materials, for civil purposes, being held by United Nations. Indeed the passage of so many years since the first attempts to reach agreement, has allowed the building in various countries of such large stocks of fissile material that the simple form of agreement originally proposed would almost certainly prove inadequate to the situation to-day.

The other difficulty, that of inadequate supplies, would be surmounted if one could use the heavy uranium isotope (238) as easily as the much rarer light one and so raise the quantity of fuel available a hundredfold or more. It had long been known that there was a way in which it could conceivably be done, but whether it was practically possible depended on certain then unknown factors. Engineers on both sides of the Atlantic have since been at work and the latest news is good. It appears that breeding reactors, as they are called, can be built which will enable a good deal of the heavy uranium to be used as fuel, possibly even the whole of it. A statement made last June by Mr. Gordon Dean, the then Chairman of the American Atomic Energy Commission, announced the success of the efforts made to breed fissionable material. This success was achieved in a special kind of reactor designed and built in Idaho by the Argonne National Laboratory, which gradually consumes U.235 and in the process changes the U.238 around it into the fissionable substance plutonium and at a rate which is at least as rapid as that at which the 235 isotope is consumed. This discovery indicates the practicability of the whole of natural uranium (as, one day, perhaps, the more plentiful element thorium) being used, when desired, as a new fuel for providing power for civil purposes—thus affording a very welcome addition to the fossil forms of fuel hitherto used. The cost of power so produced has yet to be determined, but the estimates made so far do not suggest that it will differ widely from that now customary. One of its advantages lies in the fact that as a fuel it weighs almost nothing and is therefore very cheap to transport to localities difficult to reach with older fuels. Moreover, many countries find their supplies of fossil fuels are becoming depleted in quantity, or else increasingly troublesome to mine and bring to the pit-head. As Mr. Dean has pointed out, the success of breeding should greatly aid those concerned with fuel developments to determine the best technical and economic approach to real competitive atomic power.

As it happens many of the atomic reactors designed for power production provide at the same time for the production of plutonium which is intended to be sold to the Government at such price as would enable the power to be marketed at an economic figure. But as has been wisely pointed out by Dr. Goodlet, Harwell's Deputy Chief Engineer, at the Liverpool meeting of the British Association in September, the Government market for plutonium for military purposes might collapse at any time; on the other hand the national demand for power might well outstrip our practicable output of coal, so that the economics of nuclear power would become healthier as coal prices themselves rise; and, finally, there are many lands in which the standard of living cannot be raised, as desired, on the basis of existing supplies of conventional fuel. Dr. Goodlet estimated that the improved model of natural uranium reactor now being built at Harwell should, even without any by-product revenue at all, be able to produce power at a penny per kilowatt-hour or thereabouts.

No doubt time will show various ways of building reactors for breeding; in the meantime the secrecy that surrounds so much of atomic energy development makes it difficult to determine just what has and has not been attempted already. More seems to be known about the Idaho plant than any other and a further description of it, as so far revealed, is of special interest. This account was given by W. H. Zinn of the Argonne National Laboratory in the *Chicago Bulletin* of June, 1953. From this we learn that the first reactor designed to this end was put up by the Argonne staff at the Idaho Reactor Testing Station and the diagram, Fig. 1, gives its chief components. The whole reaction takes place with fast neutrons which means that no "moderator" material is needed. The coolant is stated to be an alloy of sodium and potassium, liquid at room temperatures but boiling at 1500 deg. Fah. It needs to be kept out of contact with air, otherwise it takes fire at once. The reactor core containing the small amount of fissionable material required is hardly seen on this scale and an enlarged diagram is given in Fig. 2. Details of "security interest" are not able to be given, but the size of the core is said to be that of a "regulation football"! The coolant liquid is circulated through the U.238 blanket surrounding the core and then through the core itself. Most of the plutonium is made, or bred, in the blanket and the heat is extracted from the coolant liquid by a separately piped liquid alloy (to avoid danger to the staff by radioactivity) which goes to a steam boiler and superheater. This steam passes to a turbo-

generator of 250kW capacity. This circuitous process of power production may one day perhaps be shortened, by means yet to be discovered for transforming the atomic power directly into electric current : that would indeed be welcome. So far as the present use of " fast reactors," for any purpose is concerned, it needs to be borne in mind that certain precautions must be taken to ensure that the automatic controls operate so that the reactor cannot possibly " run away " and behave as an " untamped " form of atom bomb !

The Premier of South Australia has forecast that that State's next power station, which might be needed by 1960, is likely to be operated by atomic energy and that the power so produced would probably be found to be cheaper than that from present fuels. Professor Messel, speaking in Sydney, estimated that to supply all Australia's power needs without breeding would require about 2000 tons of uranium a year, whereas with breeding this figure would come down to as little as 15 to 20 tons. If the reported richness of the " Rum Jungle " mining area is confirmed, Australia should have no difficulty in procuring all the uranium she needs—and have indeed an exportable balance.

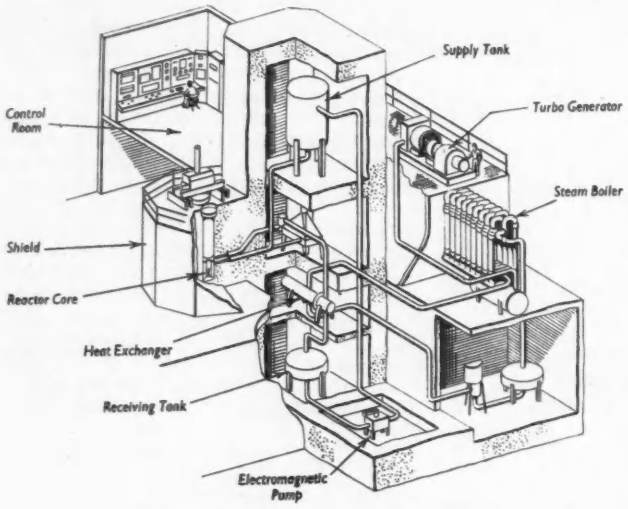


Fig. 1—Elements of Breeder Reactor, Idaho

The cost of constructing large reactors is not revealed (even if it is known), nor is the price that would be offered by the U.S. or any other government for the plutonium produced by breeding. Hence it is not yet possible to give definite figures for either capital or running costs.

Isotopes

Many of the radioactive elements used in medicine and industry are—or can be —made in atomic piles, and Harwell is now one of the principal world sources. The Harwell pile consists of very pure graphite blocks between which are spaced some thousands of bars of uranium metal, clad in aluminium. Neutrons and gamma rays are emitted and among the waste products of the pile are many kinds of radioactive elements. The half-life of such elements may range from millionths of a second to millions of years ; so that it should not be hard to select one of convenient length ! The Director of Harwell has stated that radio-cobalt, for example, has a half-life of some five years and gives out gamma rays having an energy factor of over a million electron-volts. That radiation is capable of penetrating from 2in to 6in of steel and is much used in radiography.

The 1952 shipments of isotopes from Harwell were five times as numerous as those of the year 1948, and it is interesting to note that of the 1952 total about half went to hospitals, one-tenth to industry and the same to universities : much of the balance was used at Harwell itself. That establishment also runs an isotope school giving four-week courses at regular intervals. The school teaches operative technique and the many necessary health precautions.

U.S. Atomic Energy Commission

The first half-yearly report of the U.S.A.E.C. issued in 1953 (the thirteenth of the series) was briefly reviewed in our issue of April 24th last. It reported the progress of several notable research and development ventures initiated in previous years, which when completed will raise the total U.S. investment in nuclear energy projects to some 7500 million dollars. (Incidentally, the corresponding figure for the U.S. steel corporation is given as about 4000 million.) Even so, further production facilities for fissionable substances have been found necessary and they include a new U.235 plant in Ohio, additions to the U.235 plants at Oak Ridge in Tennessee, at Paducah in Kentucky, as well as further plutonium capacity at Hanford in Washington.

The U.S.A. is reported to have in operation or under construction twenty or more reactors of varying size and purpose. They include five or more at Hanford, four at Oak Ridge, three at Idaho, three at the Argonne National Laboratory, two at Los Alamos, and the rest in Carolina, Schenectady and Brookhaven. This shows very widespread activity.

The first atomic-powered submarine, of which the keel was laid by the President in June, 1952, is expected to be launched in 1954 ; and the Naval Department expects to have its first atomic-engined carrier in about five years. The design of an atomic-engined aircraft is proving a hard task and it is not likely to materialise for some years. In a lecture given by Sir John Cockcroft before the Institute of Marine Engineers, he mentioned several possible propulsive units making use of nuclear energy which he thought could be used in submarine design. One would take an unusual form, in which metal-sheathed fuel rods of enriched uranium would dip into ordinary water and the heat generated be transferred, by water under pressure, to a steam generator. He thought that although an atomic engine of 10,000 h.p. with a thermo-dynamic efficiency of some 25 per cent should need only about 12kg of fuel per year, it might well cost three times as much as a steam plant.

Research has continued, on both sides of the Atlantic, on the provision of novel atomic weapons for Service departments. The U.S. Army has already demonstrated its 280mm cannon for firing an atomic shell : it was designed by a joint effort of the Army technicians and the Los Alamos Laboratory with the aid of the Sandia Laboratory in New Mexico. Most of such work is classified as secret. Investigations are continuing with the aim of discovering whether some less heavy form of shielding than lead or concrete for the protection of workers is feasible. Most of this work is also on the secret list, but it is understood that the possible use is being explored of composite enamel glass containing neutron absorbing substances which may also absorb other types of radiation also. (Although it sounds impressive that a nuclear bomb may release energy equivalent to 20,000 tons of T.N.T. and that its radiation effects may continue for some time, and so have a lasting effect on inhabited areas, it is stated that an ordinary earthquake can release as much energy as a million atomic bombs, and even a moderate hurricane as much as a thousand !)

The second half-yearly report (the fourteenth) of U.S.A.E.C. was reviewed in our issue of October 16th, and shows that the procurement of uranium raw materials and the preparation of the metal from domestic ores continues on a growing scale. The series of eleven nuclear detonations for military test purposes carried out between March and June at the Nevada Proving Ground was the most extensive so far made there and useful information bearing on new and improved weapons was obtained. To provide flexibility in testing new weapons the Commission is enlarging its Pacific proving grounds in the Marshall Islands so as to include the Bikini Atoll. The latest report reveals that ceramic materials are in experimental use as moderators or for shielding purposes in certain reactors : the materials so tested are stated to include graphite, beryllium oxide and Portland cement. The use of unusual materials in reactors employing high temperatures has in some cases led to acute corrosion, and research work is in hand to study its underlying cause with a view to its better control.

According to press reports the most powerful atomic bomb ever exploded in the U.S.A. was dropped over the Nevada desert testing ground in June ; its flash was seen as far afield as Canada, 1000 miles away, and a ground shock was felt at Los Angeles, 250 miles away. The bomb was carried by a " B36 " aircraft and released from an altitude of 35,000ft or more. Its explosive power is reported as the equivalent of 40,000 tons

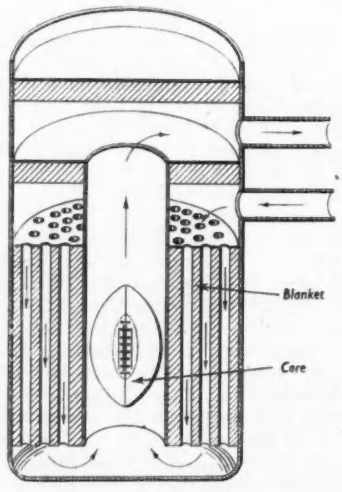


Fig. 2—Breeder Reactor Core

of T.N.T. and twice as powerful, therefore, as the atom bombs of 1945.

One of the most useful publications lately issued by the U.S.A.E.C. was its booklet on "Nuclear Power Reactor Technology," which appeared in May. It contained the "declassified" versions of reports from four separate teams from private industry, which, after a year's work within the Government's experimental organisation, issued their interim conclusions on the prospect for industrial participation in the production of electric energy and fissionable material from nuclear reactors. The published versions are stated to be but one-fourth to one-third of their original lengths and much of what those most interested would have liked to read had to be omitted. But the information they do contain gives much which is of value to engineers interested in the prospect of nuclear power enterprises. It must, however, be admitted that this "bowdlerising" of the reports has done little to improve their general intelligibility!

The four groups of firms were: The Commonwealth Edison Company with the Public Service Company of Northern Illinois; the Dow Chemical Company with the Detroit Edison Company; the Monsanto Chemical Company with the Union Electric Company, and the Pacific Gas and Electric Company with the Bechtel Corporation. (Later on a somewhat similar arrangement was made with another group, made up of the Pioneer Service and Engineering Company of Chicago, with the Foster Wheeler Corporation of New York.) The companies concerned met their own costs and their study group personnel were given liberty to discuss both "classified" and "unclassified" matter. Twelve months were allowed for these studies. One of the objects of publication is to convey useful information to those business firms not in a position to create a study group themselves. It seems clear that it was also intended to direct attention to the possibilities of dual-purpose reactors—hence it follows that favoured designs would not necessarily be those which would have been chosen had the aim been directed at power production alone, with any plutonium by-product assessed at its fuel value only. To quote the U.S.A.E.C. preface: the material does not present a balanced picture of the original reports, owing to security limitations. Very little specific reactor design and economic data could be included, but in spite of these limitations, it is felt that the release of these shortened reports will provide a helpful, though fragmentary survey, of the promise as well as the problems facing those who have an interest in the generation of electric power from nuclear energy.

It is, of course, early to expect appreciable results from this move, but, so far, it does seem doubtful whether the groups think really favourably of the prospects ahead of any reactor being able in the near future to pay its way on the basis of power generation alone. But it is thought that with improved constructional materials in respect of nuclear characteristics and thermal and mechanical properties, it might be possible to employ smaller machines, and to achieve improvements in thermal efficiency by the use of higher temperatures and pressures.

The kinds of reactor considered were many and various (as were the estimated costs of building them). One of the more attractive is a proposal that the reactor and its appurtenances should be built into a barge or ship. Construction could then be carried out in a shipyard (so simplifying security requirements), and the whole subsequently floated to, or even sunk at, some location which provided a sufficient security "exclusion area"; the shielding material would be water, and any surplus heat could be readily "dumped." With some such an arrangement as this the energy delivered might it is thought be made competitive with coal.

The U.S.A.E.C. announced recently that a contract had been placed with the Westinghouse Company for an industrial power reactor to produce 60,000kW of electric energy. This reactor will, it is expected, be installed conveniently near one of the U.235 separation plants—probably Oak Ridge, Tennessee; Paducah, Kentucky, or Portsmouth, Ohio. Its cost may be "many tens of millions of dollars," but it is expected to be in operation within three or four years.

Fundamental Research

The first of what are called "fundamental particles" was the electron discovered and named by Sir J. J. Thomson in 1897. Since that date the equally familiar proton and neutron have been discovered and from these three the typical atom could it seemed be built up. But that attractive simplicity was found not to be able to explain all the phenomena and further research on atomic structure was needed. This led to those studying the subject to become familiar with such newer particles as positrons, mesons of various sorts, hyperons and many others. Some were fairly stable but others so little so that their "half-lives" were no more than a few seconds of time; even in some cases millionths of seconds; or fractions of millionths! This whole complex subject was discussed at an international congress held in France last July when it seemed to be accepted that very much further experimental work would be needed before any generally accepted scheme of things could be formulated. The goal is, of course, to link into a unified whole the various properties of these many particles and to decide which really deserve the title fundamental and how their interactions can be calculated: but it may well be many years before this ambitious goal is attained.

For much of the research work on the constitution of matter physicists now use in their university laboratories pieces of apparatus so large as to dwarf the largest equipment found in engineering laboratories. The physicist has many objectives as his aim, but one of them is to cause protons, neutrons and other particles to bombard targets of various sorts and this usually demands enormous speeds of motion. One of the instruments to produce such effects causes the particles to build up their velocity by high acceleration in a cyclic path, sometimes circular and sometimes spiral. Most of the large pieces of apparatus used in recent years have taken this form and have very large electro-magnets to constrain charged particles to follow the selected type of circuit, with the aid of rapidly changing electric forces to provide the necessary accelerations. The largest of the kind so far built is the "cosmotron" at Brookhaven, U.S.A., which aims at a particle energy of 3000MeV (million electron volts). In Britain we have just added to our equipment the new Birmingham University plant (a proton synchroton of 1000MeV) weighing many hundred tons; a description was given in our issues of February 20 and 27, 1953. For the one proposed for use in the "International Laboratory" at Geneva no less than 30,000MeV is stated as the objective. With such huge pieces of apparatus not only can atomic structures be investigated with greater effectiveness than hitherto, but a wide and numerous range of useful radio-active isotopes can be produced. They are of service for numerous medical uses, both scientific and clinical, as well as providing tracer elements for many investigations in engineering, as well as in chemistry and in physiology.

Atomic Energy Reorganisation Committee

The British atomic establishments previously controlled by the Ministry of Supply are the Atomic Energy Research Establishment at Harwell, the Radio-chemical Centre at Amersham; besides the Centres concerned with the production of fissile material at Risley, near Warrington; at Springfields, near Preston; at Windscale, in Cumberland; at Capenhurst, in Cheshire; and at Aldermaston in Berkshire (on atomic weapons) with its out-stations at Woolwich and Fort Halstead.

In our review for the year 1952 the hope was expressed that British industry would be encouraged by the Government to take as full a share in the study of the best mode of production from nuclear energy of an economic supply of power for civil purposes as has been the rule for some years in U.S.A. A hopeful sign that the Government had become alive to such considerations appeared in the Prime Minister's statement in the House of Commons last May that, to secure the most rapid and economical development in the field of atomic energy, both military and industrial, a committee had been set up consisting of Lord Waverley, Sir Wallace Akers and Sir John Woods, with the terms of reference, "to devise a plan for transferring responsibility for atomic energy from the Ministry of Supply to a non-departmental organisation, and to work out the most suitable form for the new organisation, due regard being paid to any constitutional and financial implications." This small committee of able men have produced their report with little loss of time and without showing too great tenderness for existing procedures and without any elaborate devotion to secrecy. Secrecy, where the principles are already well-known, has the vice that it delays progress and hinders the application of the most competent brains to the problems that lie ahead.

Those brains of high competence are at least as likely to be found in the ranks of our leading industrial firms as they are in any official organisation, and since it must now become the task of industry to develop on a considerable scale the use of nuclear energy for civil power stations it is essential that relevant research information in Government possession should be imparted as generously as possible to those of the industrial staffs concerned in this novel venture. The creation, as now proposed of a British Atomic Energy Corporation under the Lord President of the Council, with Sir Edwin Plowden as Chairman, will require a new Act of Parliament before it can be set up; and we hope that the powers given to it will open up a wide prospect of activity in which industry will take a substantial part. As a writer in *The Economist* has rightly said: it is inconceivable that British technology can ultimately flourish if its leading industries continue to be excluded from knowledge of atomic science and its applications.

Atomic Weapons and the Services.—It is announced that the Minister of Supply will retain responsibility for providing the Services with atomic weapons with the transfer of general responsibility for the atomic energy projects to the Lord President of the Council, which took place to-day, January 1st. The Minister of Supply has appointed as Controller of Atomic Weapons, Lieut.-General Sir Frederick Morgan, who has, since 1951, been Controller of Atomic Energy in the Ministry.

Royal Navy, 1953

(By Our Naval Correspondent)

No. I

A NAVAL Review affords an opportunity for the nation to witness an assembly of warships which, in numbers of each type, are a fair representation of the Royal Navy as a whole. None who was present at both the 1937 and 1953 Reviews could fail to have been struck by the transformation in the shape of the Fleet which has taken place in the intervening sixteen years. In place of the eleven battleships, five aircraft carriers, sixteen cruisers and sixty destroyers—all of them designed to seek out and destroy an enemy fleet—assembled in 1937, there were only one battleship, six carriers, seven cruisers and twenty-eight destroyers (including four of the large "Daring" class) in 1953. But the number of lesser vessels had greatly increased. There were many more frigates, minesweepers and coastal craft—most of them built during the war—reminding us not only of the long-drawn-out struggle against the U-boats, but of the changes in naval strategy and tactics resulting from the type of naval forces possessed by our potential enemies. Developments in weapons and equipment during the war and post-war years, together with the drastic need for economies, made it desirable to postpone for as long as it was safe to do so, a decision on the types of ships and their armaments required for our peacetime Navy. Communist aggression in Korea put an end to further delay and in 1951 Parliament approved a substantial building programme of anti-submarine vessels and minesweepers to meet immediate requirements.

Russia has no need to use the sea routes and has neither battleships nor carriers which might contest their control against the overwhelming surface naval forces of the N.A.T.O. Powers. But she has a very large number of submarines and long-range aircraft, and it would clearly be her intention in the event of war to employ them in an attempt to deny the use of the sea routes to her enemies. These forces would moreover be supplemented by mining on a large scale and by cruiser and armed merchant raiders attacking in the focal areas of trade. Our naval construction programme was thus rightly concentrated on the provision of little ships to deal with modern fast submarines and with acoustic and other influence mines and on hastening the completion of the aircraft carriers which had been building since the war. The completion of the programme, which has been delayed by steel shortages and the shift of priorities to exports, will mark a big step forward from the appalling position in 1951, when, as the late Government announced, we could not have hoped to win another Battle of the Atlantic—to safeguard our imports of food and raw material—without the help of the United States Navy. The provision of modern aircraft for the Fleet Air Arm has not, unhappily, been treated with the same degree of urgency, and it will be some years before our carriers are equipped with adequate numbers of modern jet fighters.

The Navy of To-day

The present naval building programme should be completed by April, 1956, instead of, as originally proposed, in April, 1954. The First Lord has warned the country that our large ships—carriers and cruisers—are getting old and that a replacement programme cannot be much longer delayed. On the other hand, progress in the development of guided missiles and the use of atomic explosives in conventional missiles indicates that in the coming years there will be a marked change in the functions and armaments of large ships and even in the types of ships required. Large ships, moreover, take a long time to build and it seems therefore probable that the Royal Navy, as it will be when the rearmament programme is completed, will be the Navy we shall have during the next five years. As official pronouncements have emphasised, it will be a Navy intended primarily to carry out the defensive function of safeguarding the sea communications. In this respect it provides a substantial contribution to the naval strength of the N.A.T.O. Powers, and there was little need for the surprise and alarm occasioned by the First Lord's reference to the "powerful strength of the Russian surface fleet." In broad terms, the Royal Navy during the next five years will consist of the following vessels :—Five battleships ; seven aircraft carriers capable of operating the latest types of jet fighters ; eleven aircraft carriers (including four pre-war designed fleet carriers which have not been modernised) for operating general reconnaissance and anti-submarine aircraft ; twenty-four cruisers, several of which are now approaching their age limit ; eight "Daring" class destroyers, which might well be classified as small cruisers ; sixty-five destroyers ; sixty-nine fast frigates, either newly built or converted from destroyers ; 130 minesweepers of new design ; several fast coastal patrol craft of new design and a large number of wartime lesser ships of various kinds.

Under existing conditions, when the Royal Navy has no need to fight for the surface control of the sea routes, it is apt to be forgotten that it has also an offensive function. Task forces have to be provided—each consisting of a substantial number of carriers and cruisers—for the invasion and capture of strategical coastal areas. Losses would be heavy and the number of these ships the Royal Navy can now provide is totally inadequate. It may well be that while the North Atlantic Treaty Organisation is in force offensive operations can be left to the "mighty and powerful United States Navy." But this is not a happy state of affairs for a great maritime country which became great through sea power and will only remain a great and influential nation through her sea power. The time is indeed approaching when we shall have to choose between conscription to maintain large armies and the building up of a navy capable of taking the offensive.

The Navy of To-morrow

Armament experts, who are entitled also by the rank and position they hold to speak with authority, believe that it will be from ten to fifteen years before the development of guided missiles is sufficiently far advanced markedly to influence the conduct of sea and air warfare. It is thus of interest, in the light of the considerations advanced above, to discuss the effect which these developments are likely to have on the functions and armaments of existing ships and of ships whose design should be considered now if they are to be in service ten years hence.

Battleships.—The Royal Navy has five battleships—one in commission and four in "mothball" reserve. There is a prevalent, but mistaken, belief that these vessels serve no useful service, presumably because our potential enemies have no ships of this type for them to fight. Under existing conditions, however, they would provide a powerful and concentrated anti-aircraft armament during offensive operations and would thus be of the greatest value as the hard core of a task force. It is essential to keep one in commission to train personnel in the working of this class of ship, but the remainder are looked after by a few caretakers at negligible cost. In mothball reserve they are well preserved and could be brought forward for service when required, at relatively short notice.

All of them have still a comparatively long life and it may well be that they—and ships of similar type to be built in the future—will again be employed as the main offensive unit of the fleet. Now that the United States Army has an 11in atomic shell-firing gun, it is beyond doubt that the warhead of the large guided rocket can be filled with atomic explosive. Bombardment missiles similar to those already successfully tested in the United States—they are 48ft long, weigh 5½ tons and have a range of 500 miles—are thus likely to replace bombs carried by aircraft which, the Minister of Supply has assured us, cannot hope to outmanœuvre the anti-aircraft missiles now under development. Though one of these rockets could be launched and guided by a large bomber or submarine, their limited range suggests that they will be used to the best advantage by a nation which has sea power, for launching from battleships off an enemy's coast.

Fleet Carriers.—British and American views on the primary function of the large fleet carrier are not wholly in agreement. The United States Navy is now building giant 60,000-ton carriers to enable medium-range aircraft to bomb inland targets and thus to reinforce the strategical bombing carried out by long-range shore-based bombers. British policy is to build carriers large enough and fast enough to operate at the utmost speed the maximum possible number of modern jet fighters and fighter-bombers, both for actions between surface ships and to provide air support for the troops during amphibious operations, pending the establishment of R.A.F. bases ashore.

Whether the United States will build many more 60,000-ton carriers seems to depend on the rate of progress of guided missile development. But the requirement for large carriers capable of operating the latest jet fighters will remain, though the steam-operated catapult, the angled deck, improved arrester gear and other innovations have greatly facilitated flying operations from these vessels. The recently completed "Centaur," and the "Hermes" and "Victorious" now completing, have all been fitted with the angled deck and it seems likely that future fleet carriers will not be as large as the 36,800-ton "Eagle" and "Ark Royal." When the present rearmament programme is completed the Royal Navy will have seven carriers suitable for offensive operations, including the pre-war designed "Victorious," now being reconstructed and modernised. The extensive refit of this vessel is taking a very long time and it appears preferable to build new carriers rather than to modernise the four remaining fleet carriers of pre-war design. Without reconstruction they will still be very valuable for operating general reconnaissance and anti-submarine aircraft.

Light Fleet Carriers.—Britain's light fleet carriers are vessels of some 13,000 tons with a speed of 24 to 25 knots, built during the war

at a time when economy in naval building was essential. They were intended to meet the immediate requirements of the Japanese war. With the completion of the "Majestic" (H.M.A.S. "Melbourne") and H.M.C.S. "Powerful," both now building for the Dominion Navies, the "Vengeance" and "Magnificent" will be returned to the Royal Navy, which will then have seven ships of this class and four unmodernised fleet carriers, all suitable for operating aircraft for

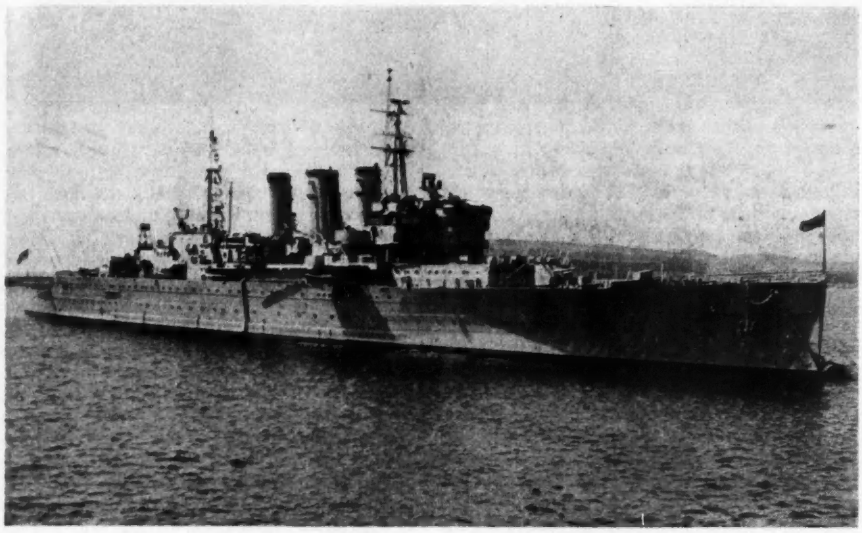


Fig. 1—Trials Cruiser H.M.S. "Cumberland"

general reconnaissance and anti-submarine duties. It was thought at one time that these ships would have to act as convoy escort carriers because of the increased weight and size of submarine detecting devices and anti-submarine weapons now carried by aircraft, but with the steam-operated catapult it will again be possible for converted merchant ships to carry out this duty, as they did in World War II.

Light fleet carriers will, in fact, be employed for the purpose originally intended—for general reconnaissance work and submarine "hunter-killer" task force operations, for which speed in operating and defence against heavy air attack are not essential requirements. A total of eleven carriers for these duties is none too many in view of the many focal trade areas to be protected, and it seems very desirable to complete the "Hercules" and "Leviathan," whose construction has been suspended since 1946. It is, however, a difficult question for the Admiralty to decide—whether to build more large carriers for offensive operations or medium-sized carriers for trade protection. Neither of these requirements is in any way affected by the development of the guided missile.

Cruisers.—The cruiser situation has remained unchanged since the Navy reduced to a peacetime standard after the war, except that the few cruisers we have are rapidly getting old. Work is still suspended on the three powerful ships of the "Defence" class, laid down during the war, pending a decision on their armament. This problem is under investigation in the old cruiser "Cumberland" (Fig. 1), which has been fitted out as an experimental ship, and it is of interest to note that two United States cruisers are now being rearmed with guided missile launching platforms for trial. In comparison with the 6in shell fired by a modern cruiser, a warhead of equivalent size would contain a much greater amount of explosive and, in view of its longer range and greater accuracy, the guided missile would seem to be the most effective armament for this type of ship. Of our existing twenty-four cruisers, five will be twenty years old, eight will be fifteen years old, and all but three of the remainder will be over twelve years old by 1956. The estimated life of these vessels is twenty years, and is is thus essential to commence a replacement programme without further delay. In any event we require many more than twenty-four cruisers for the defence of focal areas of trade, for offensive operations and for the many and varied duties they are called upon to carry out, both in peace and war. The Royal Navy had sixty cruisers in 1937, and it should be our aim to build up to this number as far as our resources permit.

Destroyers.—At the launching of a "Daring" class destroyer some two years ago a member of the Board of Admiralty expressed the view that the "Daring" class are likely to be the last vessels recognisable as conventional destroyers to be built for the Royal Navy. The eight "Darings" were all laid down during the war and only recently completed. Of 2600 tons with six 4·5in guns in twin turrets they might well be classified as small cruisers. Destroyers were intended to attack heavy ships with torpedoes by day and night and to protect their own ships from similar attacks. They were thus given a relatively heavy gun armament to eliminate opposition from hostile destroyers. Russia has upwards of 100 of these vessels, of varying age and efficiency, and the Admiralty is retaining, besides the "Daring" class, sixty-five of our post-war force of 110 destroyers. The remaining forty-five are being converted to fast frigates for anti-submarine duties—the quickest and most economical method of meeting an urgent requirement (Fig. 2 and Plate 1). No doubt more of them will be converted to frigates in due course, but as long as destroyers remain in the navies of potential enemy Powers it will be necessary to build similar ships capable of meeting them on equal terms. The answer may well be some form of compromise frigate with more guns and a smaller anti-submarine armament than those in the frigates now building.

Other Surface Vessels.—A Royal Yacht and a new naval hospital ship have been urgent requirements since the war, and there was thus good reason for the laying down in June, 1952, of H.M.S. "Britannia," the Royal yacht, which is to be used as a hospital ship in time of war. A ship of 4000 tons, she will require very little structural alteration for conversion to a hospital ship. A special feature is her shelter deck, which is strong enough to permit the landing of a helicopter with patients. Of the twenty-four frigates planned under the rearmament programme, thirteen are now building. These ships are of all-welded construction and are of four kinds: two for anti-submarine duties (one having armament and equipment superior to the other), a third for anti-aircraft, and the fourth for air detection duties. Forty-five of our post-war fleet of 110 destroyers have also been earmarked for conversion to frigates, and of these thirty are already in service or nearing completion. Others will shortly be taken in hand. The cost of conversion is about £500,000, compared with £1,333,333 for the construction of the superior anti-submarine frigate.

No less than two-fifths of the total cost of new construction under the naval programme is being expended on minesweeping vessels of new types (Plate 1), to deal with magnetic and acoustic and other influence mines. It is well to bear in mind that in the future we may expect influence mines to be operated by the hull of a ship emitting light waves in the sea directly under and around her, or by heat waves emitted from the ship. Seventy-six coastal minesweepers for operating in shallow coastal waters and fifty-four inshore minesweepers for mine clearance in river mouths and harbour entrances are now completing, under construction or projected.

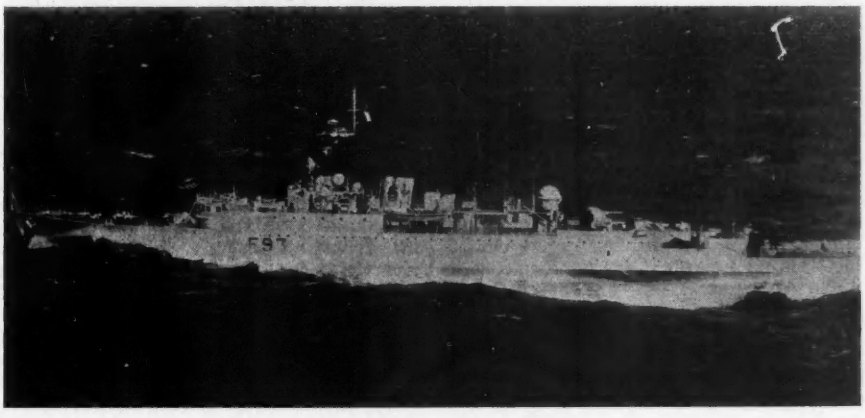


Fig. 2—H.M.S. "Vigilant"

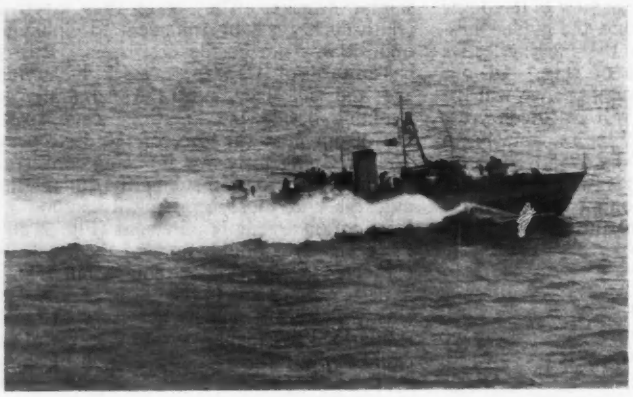


Fig. 3—H.M.S. " Bold Pathfinder "

Fig. 4—H.M.S. " Gay Archer "

Aluminium is used for both the framing and the structural casing and the outer bottoms are wood planked, the hulls thus being largely non-magnetic. All are diesel driven. Contracts are also being made in British yards to the value of 11,000,000 dollars for the building of inshore minesweepers which will be allocated to the N.A.T.O. countries as part of the United States Navy's " offshore procurement " programme.

Many other small craft of various kinds are building for the Royal Navy : fast patrol vessels, motor gun (or torpedo) boats of new design, and seaward defence vessels for detecting and destroying submarines in the approaches to defended ports. Propelling machinery of various types is in use or under trial for these vessels. The Metrovic " G2 " gas turbine—a development of the " Beryl " jet aircraft engine—has been installed in two of the " Bold " class patrol craft (which also have diesel engines)—Fig. 3 and Plate 1—and two prototype Rolls-Royce " RM.60 " gas turbines have been successfully tried out in the war-built gunboat " Grey Goose." The latter are the first successful gas turbine engines to be specifically designed for naval use at sea. The new "Gay" class (Fig. 4), which are powered by Packard engines, can be armed either as gunboats or torpedo boats. Of all-wood construction, they are a development of the short motor torpedo boats produced during the war and the first of the class—the " Gay Bombardier "—was completed in April. A former German E-boat has been used to try out the new " Deltic " diesel engine, which has been fully described in this journal. The engine has proved extremely successful under trial at sea and is claimed to be the most outstanding lightweight diesel engine in the world to-day. Developed by D. Napier and Son, Ltd., the " Deltic " is intended for use in high-speed patrol craft to replace the petrol engine with its fire risks and heavy maintenance problems. Official information of speed attained is not yet available, but fast patrol and coastal craft constructed over the next twenty years—driven by the " Deltic " engine or by gas turbines, or a combination of both—are likely to have a speed of at least 40 knots.

Submarines.—Holland has now returned two " T " class submarines which have been on loan since 1948 and with three still on loan to the French Navy the Royal Navy is left with fifty-seven of these vessels, all laid down during the war. Submarines are the only type of craft suitable for operating in waters controlled by the enemy and are thus essential for even the strongest naval Power. But until the latter part of World War II they were always in a dangerous condition at night, when they came to the surface to charge their batteries, and the development of radar and other devices greatly increased this danger. Indeed, from 1943 onwards U-boats found it no longer practicable to remain on the surface for any length of time. By then it had become clear that ships whose offensive and defensive power depended on their ability to operate submerged must in the future be true submarines. No longer would they be vessels normally remaining on the surface until the need for submerging arose, but vessels which habitually navigated and operated submerged. The only immediate solution was to develop the Dutch invented schnorkel breathing tube—now called the snort—which permits the use of the diesel engine while remaining submerged at periscope depth. All British and United States modern submarines have therefore been fitted with a snort, together with larger batteries where practicable, and streamlined and reconstructed externally to give the best possible form for high underwater speed (Fig. 5).

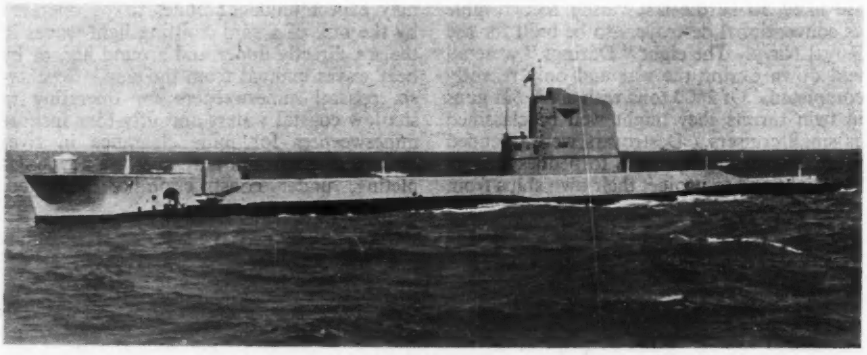


Fig. 5—H.M. Submarine " Totem "

These measures, it was recognised, would only be temporary, and by the end of the war the Germans had four uncompleted U-boats equipped with Walther cycle turbine engines using hydrogen peroxide as oxidant for fuel and thus requiring no air or snort. The Germans anticipated what has in fact since happened, for in fine weather the snort can now be detected by radar at a considerable distance. The development of the helicopter and sonobuoy and radar have to a considerable extent eliminated the advantages of the snort. Both the British and United States Navies have been using these German U-boats to try out and improve on the Walther cycle engine, but the United States Navy is now concentrating on another and superior type of true submarine, with a nuclear power plant. One is expected to be completed this year and the keel of another was laid down in September. The former is to have a thermal reactor and the latter an intermediate reactor plant—the neutron fission being in the one case at slow speed and in the other at intermediate speed. The heat from the reactor will be taken away in a primary coolant consisting of distilled water under pressure, which will be pumped through a heat exchanger, in which steam will be generated for the turbines. Air supply for the crew will be carried in the form of high-pressure oxygen and fresh supplies of oxygen will also be extracted from sea water. Both submarines will have a small diesel, batteries and snort to provide for the temporary shutting down of the power plant. Subject to the devising of methods for the removal of the carbon dioxide exhaled by the crews, which cannot all be removed electrically, these vessels will have an unlimited endurance submerged and will be able to proceed at any desired depths at speeds estimated at between 20 and 25 knots.

(*To be continued*)

CENTRIFUGAL CASTINGS.—We are informed by the Sheepbridge Engineering, Ltd., that by agreement with the United States Pipe and Foundry Company, the special method developed by the American firm for making long cast cylinders and tubes can now be used by Sheepbridge Steel Castings, Ltd., and Sheepbridge Stokes, Ltd., of Chesterfield. With this horizontal rotation process there is applied round the walls of the mould a special refractory spray that induces the casting metal to flow evenly throughout its length. Sheepbridge Steel Castings, Ltd., proposes to spin cast piping in high alloy steels and nickel base alloys by this process as well as heat-resisting and corrosion-resisting steel alloys in long castings for ultimate use as rollers in heat treatment furnaces, runout rolls for steel mills, &c. It is stated that experimental 10ft long iron cylinders of 8in diameter have already been successfully cast by this new " Burlington " process at the Chesterfield Works of Sheepbridge Stokes, Ltd.

Labour in 1953

By GERTRUDE WILLIAMS

No. I

A YEAR is a very short time in the life of a community—much too short to enable one to disentangle the sporadic events from the long-term trends. We wind our way amongst the trunks of the trees and have no chance to see the shape of the forest. It is a good thing, therefore, if occasionally some outstanding circumstance makes us stop for a time to get a longer perspective, and Coronation Year has provided just such a halting place. Everybody hopes that it will be fully another half-century before the great happenings of this summer are repeated and, standing poised half-way through the twentieth century, we can look back over the changes that have taken place since this century began. Certainly, in no branch of our national life have those changes been more profound than in the world of labour.

Poverty

Poverty is a relative term, in two senses. Even the concept of the basic subsistence level, the minimum, that is, that is thought to be necessary for the maintenance of life and physical efficiency, is not a constant but alters as the ideas of the community change with regard to standards of decency, appearance, &c. Standards of food, clothing and housing that are now held to be the lowest acceptable to a civilised community would have been thought of as undreamed of luxuries a hundred years ago. And in the second sense it is even more relative, for even a competence which allows of a good basic standard of living is felt to be poverty, when the gap between the ways of life of the richer members of the community and those only just able to keep their noses above water is very marked.

In both these senses the amount of poverty now is negligible in comparison with that of 1900. The constituents of the basic essentials of life are now far more comprehensive than they were then, yet, in one way or another, either by its own earnings or by social provision, practically the whole population is maintained above this level ; whilst the economic gulf between the classes has narrowed so considerably that what differences there are in ways of living of the main groups of the community are the result rather of differing choices in expenditure than of differences in the size of incomes. A number of inter-related factors have combined to bring this about, amongst which must be stressed the rise in earnings, the spread of collective agreements, the virtual abolition of unemployment and the great increase in the proportion of the income of the household that is provided by social benefits instead of wages.

Changes in the value of money have been so great and are so impossible to calculate over a period of such rapid development as the last half-century, that a comparison of money wage rates would be of little value. But even without that precision we know that average weekly earnings for men over twenty-one of over £9—the amount given in the latest official records as the average earnings in the last week in April of last year—represents a very marked increase in real value over those obtained in 1900. Moreover, these earnings are gained in a much shorter week ; for these average earnings relate to an average of 47·8 hours a week, including overtime. A clear comparison of hours with the beginning of the century cannot be made as the length of the working day was then a subject of collective agreement in only a small minority of trades ; but the fact that in 1900 there was a determined, but unsuccessful, effort on the part of workers to persuade Parliament to fix a maximum legal working day of twelve hours indicates that in the majority of male industries the hours worked must have been more than this. The present working population have then not only higher incomes but also very much more leisure in which to enjoy them.

High earnings calculated for a particular week in the year need not, however, necessarily point to a high standard of living. It might happen that the week chosen was exceptionally favourable and that rates and earnings might show an appreciable fall at a later date ; or that the opportunity to earn at all might be so irregular that the annual earnings would not be proportionate to this weekly amount. But in both these ways the present-day worker is at an immense advantage over his predecessor. Fifty years ago the total membership of trade unions was only 2,000,000, concentrated in the heavy industries, printing and textiles. The vast majority of workers had not protection of their rates and conditions and employers could, and did, take advantage of this lack of bargaining power to play off one against another and use the fear of being out of a job to cut rates whenever the chance occurred. Nowadays this is no longer possible, for about 80 per cent of all wage earners have wage rates fixed by collective agreements—9,500,000 are members of trade unions, and close on 4,000,000 are in trades subject to statutory wage regulation. No employer now could dare to lower wages before months of negotiations had taken place. Moreover, these wages are earned regularly, for since 1940 there has been practically no unemployment and holidays are paid for : so the wage is earned fifty-two times a year. How much unemployment there was in 1900 we cannot tell for there was then no unemployment insurance and, consequently, no records of the numbers out of work. Some of the unions paid benefits from their own funds to unemployed members and from their accounts we can judge that the numbers varied from 3 per cent to 8 per cent ; but none of the trades with irregular employment, and particularly none of the casual sorts of work, were organised at all and it is certain that the figure for unemployment would have been very much higher had they all been included. From 1920, when national compulsory insurance began, we have complete records and during the period between the two wars the unemployment percentage never fell below nine and twice rose above twenty. Nowadays, on the contrary, the percentage is under two and has been at this low level since the early days of the war—a figure which records merely the short interludes between jobs when a worker is moving from one employer to another. It would be difficult to overestimate the difference to standards of living resulting from this regularity of earning capacity. So often in the past, a hardly won improvement in living conditions was lost through weeks out of work when savings were exhausted and household goods pawned, whereas now, the worker knows that he can have a fair amount of confidence that the level he has achieved will be a solid foundation for the future.

The Welfare State

But perhaps there is no facet of working life which shows so remarkable a change as that brought into being by the Welfare State. National insurance and retirement pensions, free education and the National Health Service, subsidised food and house rents have brought the State as a working partner into every household. In 1900 the total expenditure on social services was £36,000,000, representing £1 per head of the population ; in 1920 it was £247,000,000, £5·8 per head. In the years just before the war it had risen to £9·7 per head and a total of £450,000,000, and in the last full year, 1952, it was £35 per head and £1650 million as a total. Divided amongst the families of the community this represented an average expenditure of 56s. per week. To an ever increasing extent the income of the average family is no longer solely dependent on the earnings of the breadwinner but is drawn also from the pockets of the whole community. Not every family gets the same benefit. The childless family gets little direct help from the educational services or from subsidised housing and less than average from the National Health Service. This is as it should be. Social provision is directed as far as possible to the points where need is likely to be greatest ; and, as a result, we now have a strong buffer between the family and poverty that must be considered one of the great contributions of this century to the dignity and welfare of the general body of the community.

It is against the background of this general development that the events of the last year must be reviewed. Organised labour is no longer fighting for its existence, but is one of the most powerful forces in the community. Wage-earners can no longer justly think of themselves as the exploited tools of their employers' cupidity with no concern and no interest in the fortunes of the industries in which they work, but have to face the responsibilities which are the corrollary of their strength and power. This view was very forcefully expressed by Mr. Tom O'Brien, M.P., Chairman of the General Council of the Trades Union Congress, at the Annual Conference of the T.U.C., when he urged trade unionists to recognise the danger of trying to push up wages instead of doing all in their power to increase productivity. It was nonsense, he insisted, for trade unionists to say that they could take no part in productivity campaigns whilst industry was still mainly privately owned, on the ground that this meant more profit for the bosses and no benefit to themselves ; for experience showed conclusively that improved standards for workers were obtained from prosperous industries and not from those in a depressed condition. What object is served by forcing up wages to the point where the consequent higher costs of production result in loss of export markets ? A good rate for the job is important, but, he argued, it is just as important to have a job to which the rate applies.

Strikes

Mr. O'Brien's sound common sense is, unfortunately, by no means universal in the trade union movement and was conspicuously lacking in the recent strike called by the Confederation of Shipbuilding and Engineering Unions — the one-day strike of December 2nd. This is the first time that a

one-day " gesture " strike of this size has been organised in this country and it is difficult to know what those responsible believed could be achieved by it. There may, indeed, be a place for a strike of this sort in certain circumstances and three situations may be considered in which some useful results might be expected. For example, a group of workers in an occupation which normally denies itself the advantages of strike action because, owing to the particular part it plays in the life of the community, it generally subordinates its own interests to the public welfare—a public utility, for instance, or school teachers—may feel that society has come to take them so much for granted that they will never get serious consideration of their grievances unless something is done to jolt people into recognition of their existence ; or, again, a weakly organised body of workers may manage to make this one despairing cry in the effort to call attention to their wrongs, though they could not support a long strike, and for a third instance one might find a well organised group which thinks this a less expensive demonstration of strength than a full-dress strike, if they have reason to believe that the reasons that their employers are unwilling to make concessions is that they are confident that the unions will not take any hostile step. But the engineers do not fall into any of these categories. Not only are they amongst the most highly organised workers in the country, but there is no question of their power and of their readiness to use it, should all else fail. There is a well-recognised and familiar procedure for negotiation and, in addition, various statutory methods of conciliation and arbitration which can be called into action. On this occasion the alternatives were not even fully tried—much less proved a failure. Nor does a token strike of this sort give any indication of relative strength such as to frighten employers off a " real " strike ; for success in a strike depends on the power of endurance and nothing in a one-day stoppage can give any sound indication of this, any more than the readiness to shake the mailed fist in international affairs is a sure guide to the ultimate victor should open hostilities break out. Not only is there no need for such highly organised workers to call attention in this way to their demands, but the great loss and dislocation they cause make the achievement of any part of what they ask for even more difficult.

This is not the only occasion during the year on which impatience has led to a stoppage of work before alternative methods of coming to an agreement had been given a reasonable trial. In the case of the electrical contracting industry, in which during July, strikes took place at selected sites in the hope by the Electrical Trade Union of bringing maximum industrial pressure to bear on the employers at the minimum cost to themselves, the verdict of the Court of Enquiry set up by the Minister of Labour to clarify the issues can best be summed up as " a plague on both your houses." The Court gave it as its opinion that both sides were equally to blame for failing to operate the industry's existing joint machinery for negotiation. The union evidently believed that the employers were hoping to undermine the authority of the union officials and gain time by delay tactics ; the employers thought that the union was activated by political rather than industrial motives and that it was not really concerned to discover a basis for peaceful agreement. As a result neither side was willing to mention the possibility of arbitration until feelings on both sides were so exacerbated that such a reference would not have been considered dispassionately. The Court recorded its " considered opinion that there have been unfortunate errors of judgment on both sides and that arising therefrom the important and real issues between the parties have not yet been fully explored in an atmophere free from prejudice and suspicion."

A somewhat similar reprimand was the gist of the report of the Court of Enquiry set up to investigate the dispute between the Austin Company and the National Union of Vehicle Builders. There were here two tangled skeins of disagreement, one of redundancy, the other of alleged victimisation, and a good deal of difference of opinion between the disputants as to which was the more important. Changes in demands and in designs frequently make it necessary to lay off groups of workers who have become redundant, sometimes for a short period, sometimes more permanently. The Austin Company has for some time adopted the practice of giving notice in the usual way to redundant workers, but trying as far as possible to re-engage them as occasion offers, or to transfer them to other employment. On this occasion the trouble began in the summer of 1952, when the company ceased production of a certain model and consequently gave notice to several hundred men. When announcing this action the company official gave an undertaking to the effect that the usual policy would be followed of " last in, first out," and of re-employing ex-Austin workers when production of other models expanded. Meanwhile, the personnel manager had been given instructions not to engage any new labour whilst the discharges were taking place.

The union later complained that these undertakings had not been kept, that new labour was engaged whilst ex-Austin employees were still available and that, in particular, one man, a prominent shop steward, had been kept out of employment on account of his union activities. After many months of angry discussion the N.U.V.B. called a strike, although, as it later admitted, it contravened one of its own rules in doing so without first getting the consent of the branch meeting. When the strike had lasted for six weeks the company countered by issuing an ultimatum threatening dismissal to any striker who did not return to work by the end of the week and, in fact, 1583 strikers received a letter of dismissal on this count. Meanwhile, however, the T.U.C., to whom the union had applied for assistance had advised the union to make an application to the Minister of Labour for a Court of Enquiry to be set up and to call the strikers back to work in the interim. It seems likely that the company knew of this development when the letters of dismissal were sent and it is unfortunate that it did not hold its hand for a time to give the strikers a chance to consider the advice given them. As the Court finally said, " both the company and the N.U.V.B. adopted a regrettably inflexible attitude and neglected reasonable possibilities of compromise." On the main issue, however, the Court gave its opinion that the company had honourably fulfilled its undertakings not to take on new labour whilst the discharges due to redundancy were in progress and later to give special consideration to ex-employees. Nor had the choice of employees to be dismissed been in any sense conditioned by the union activities of those involved ; it was rather that the union had tried to exert improper influence in getting the particular shop steward more favourable treatment than his fellow workers.

Redundancy

This redundancy issue is one in which feelings on both sides are usually bitter. The constant changes in techniques and markets which are part of a dynamic economy involve constant alterations in the numbers needed for various processes and, unless these adjustments can be made, progress is hampered, productivity lowered and costs increased. There is no reason why a firm should feel a moral obligation to keep permanently on the books a worker to whom it has once given a job ; yet it is to the interests of both sides that an effort should be made to provide a reasonable degree of continuity of employment even if this sometimes means some sacrifice of flexibility. In addition to greater regularity of employment and earnings, the worker gets a sense of belonging to the organisation —of being a member of a corporate activity instead of merely a bit of its machinery, and expendable at that. The firm, by making clear to its workers its sense of corporate responsibility, gains the loyalty of those in its employment. Some kind of agreement, therefore, partially limiting the freedom of the company when the state of trade requires some workers to be temporarily laid off, is sensible on all counts. But the position is entirely different when the question is not one of short-lived fluctuations in the demand for a particular kind of worker, but involves a long-term change due to improved methods of production or organisation. Such was the case in the regrettable strike of tanker drivers in October.

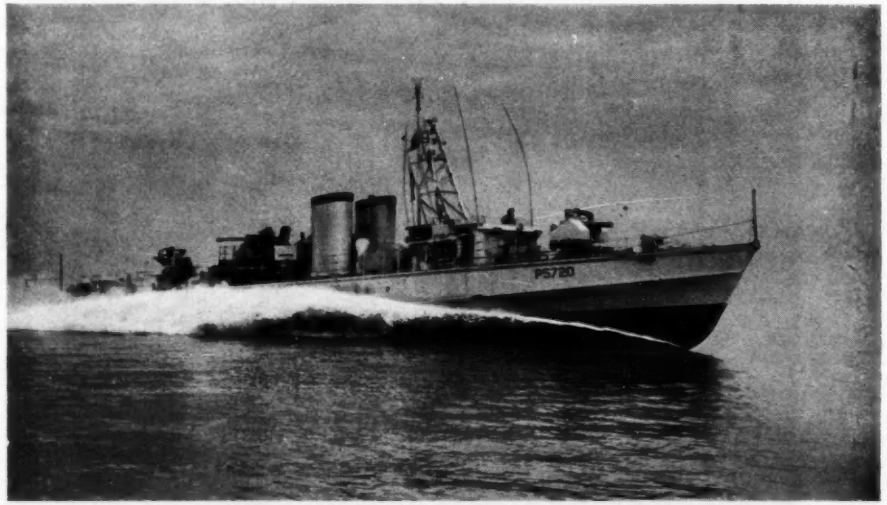
In order to rationalise the distribution of oil and petrol the oil companies wished to give up handling for themselves all but the large loads, leaving local contractors to make the smaller deliveries. They also wanted to economise by abolishing the practice of paying a " mate " to sit beside the driver when there is practically nothing for him to do. Whilst negotiations on these and other matters were proceeding with the Transport and General Workers' Union, 3000 men in the London area took matters into their own hands and struck because they feared that the proposed arrangements would mean fewer jobs and less overtime pay.

The companies pointed out that these fears were without foundation for the drivers no longer employed by them could find work with the local contractors whilst the displaced " mates " would be given other work with the companies. Even supposing, however, that this had not been the case it is difficult to see what justification for striking existed. No improvement in efficiency can ever take place if workers consider that they have an inalienable right to permanent employment in a particular job. The strike failed because of the firm action of the Government in employing troops to keep the wheels of communications moving ; but it is significant that the union, though it did not support the action of the strikers, had little power to convince them of the futility of their methods of trying to get what they want. It seemed doubtful even whether the men on strike were fully aware of the negotiations that the union was carrying on on their behalf, and this provides further evidence of that lack of an effective transmission belt between union officials and the rank and file which has shown itself in many disputes in recent years.

(To be continued)

SMALL NAVAL CRAFT OF 1953

Inshore Minesweeper "Inglesham"

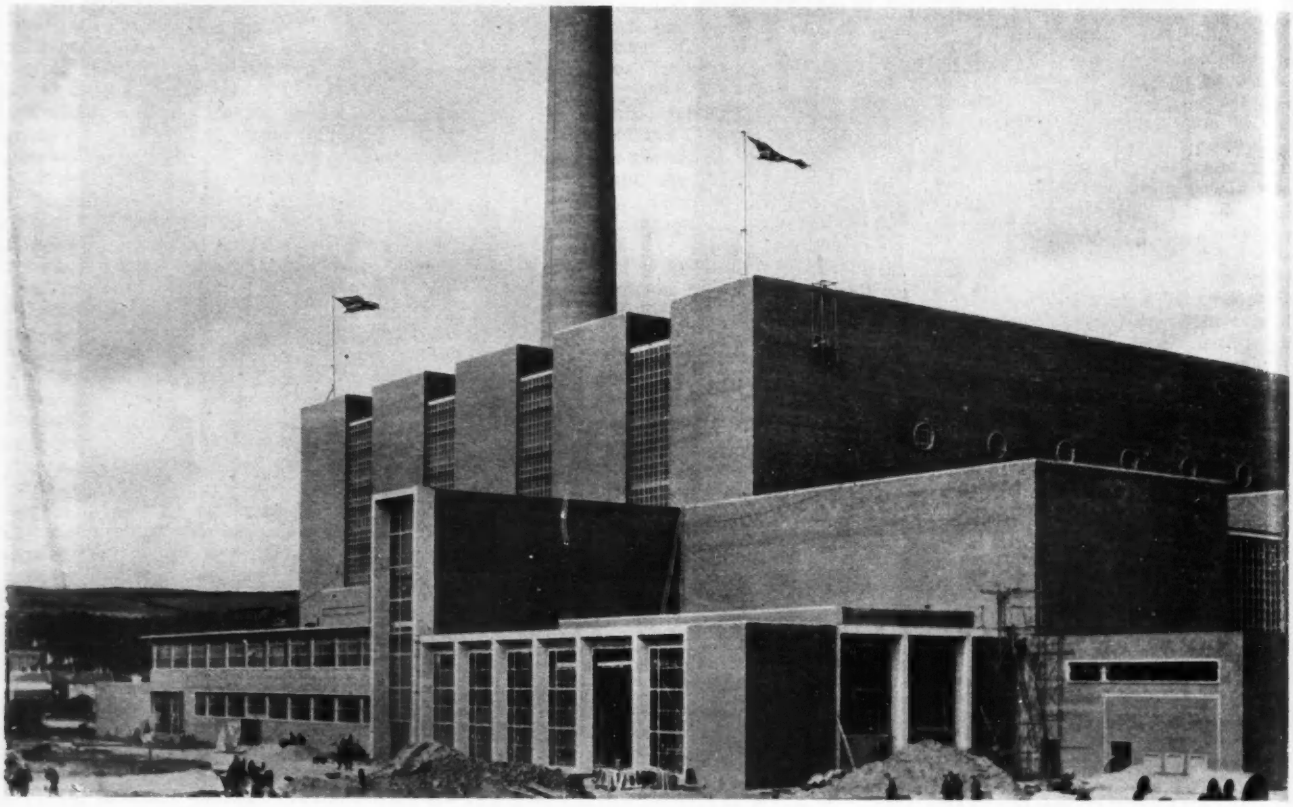


Fast Patrol Boat "Bold Pathfinder"

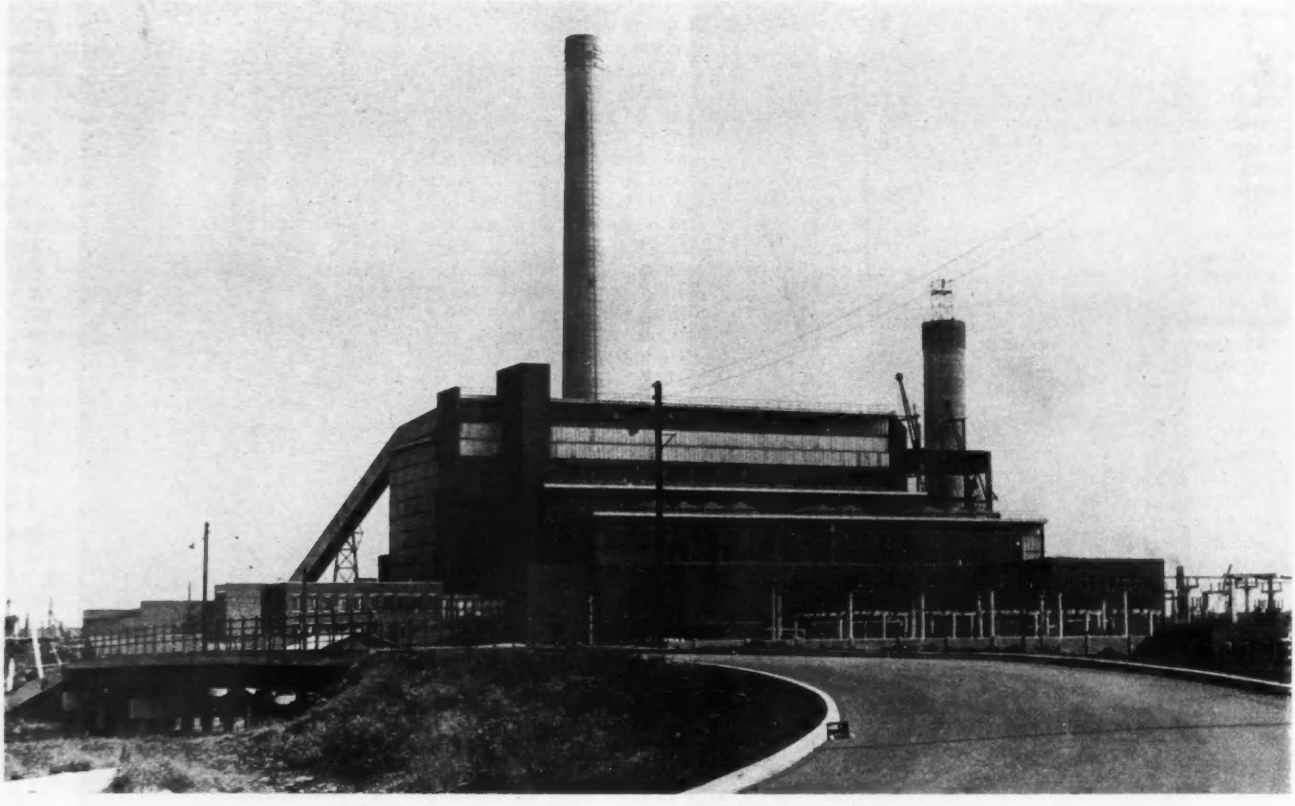
Fast Anti-Submarine Frigate "Wakeful"

Coastal Minesweeper H.M.S. "Coniston"

POWER STATIONS OF 1953

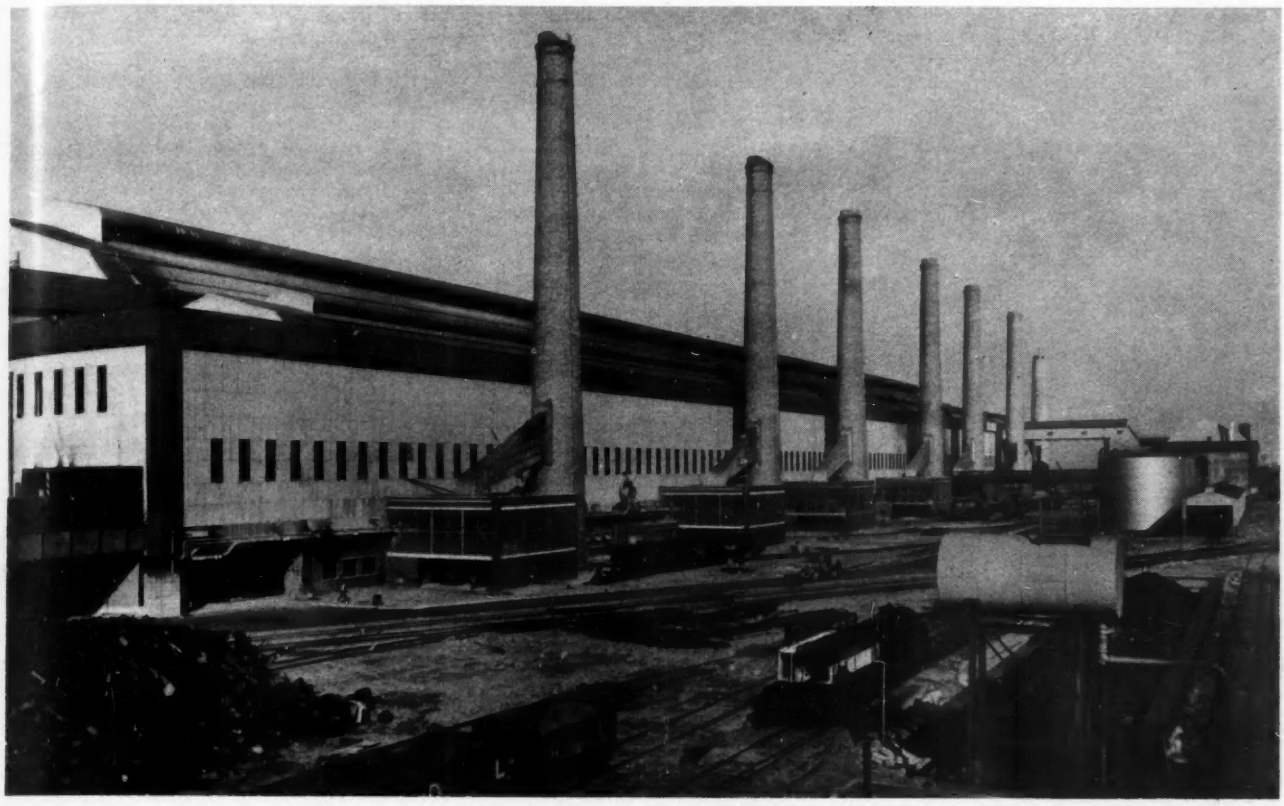


Carmarthen Bay Generating Station

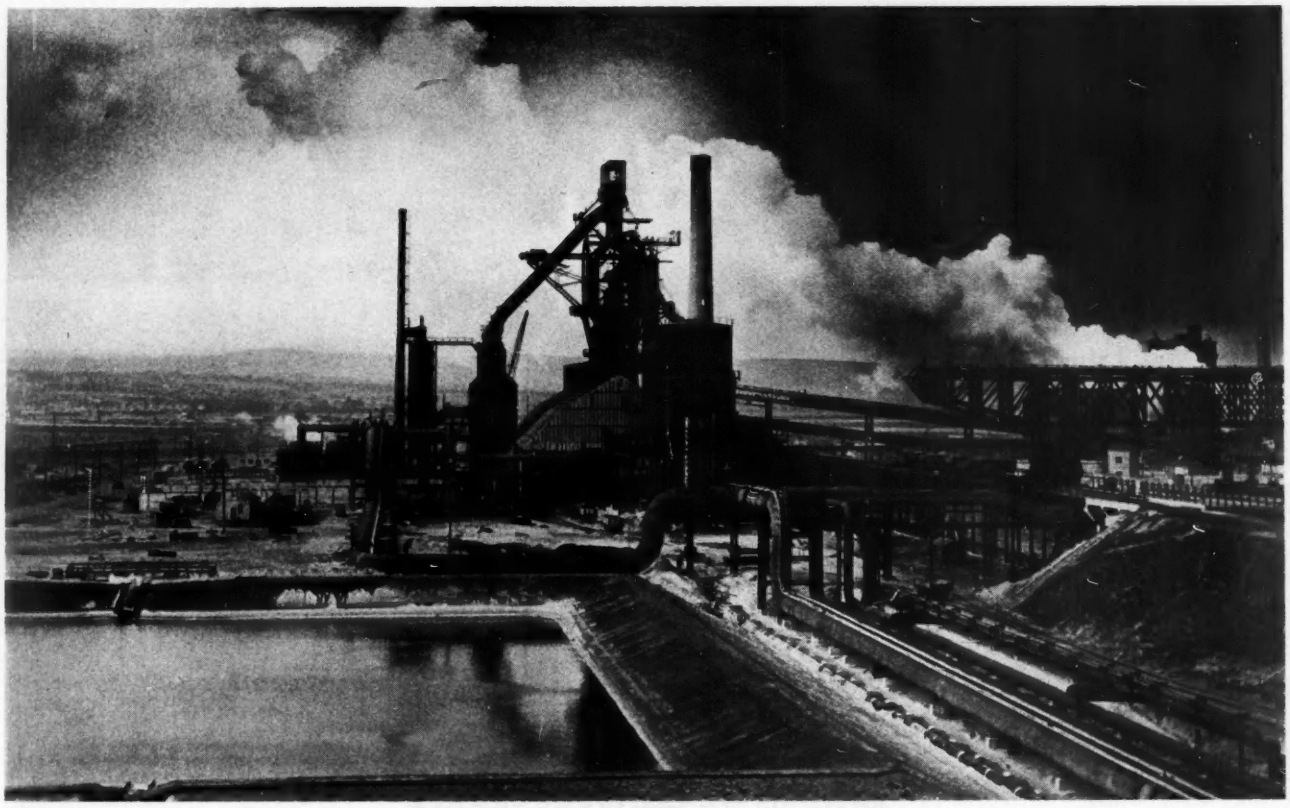


Doncaster Generating Station

STEELWORKS OF 1953

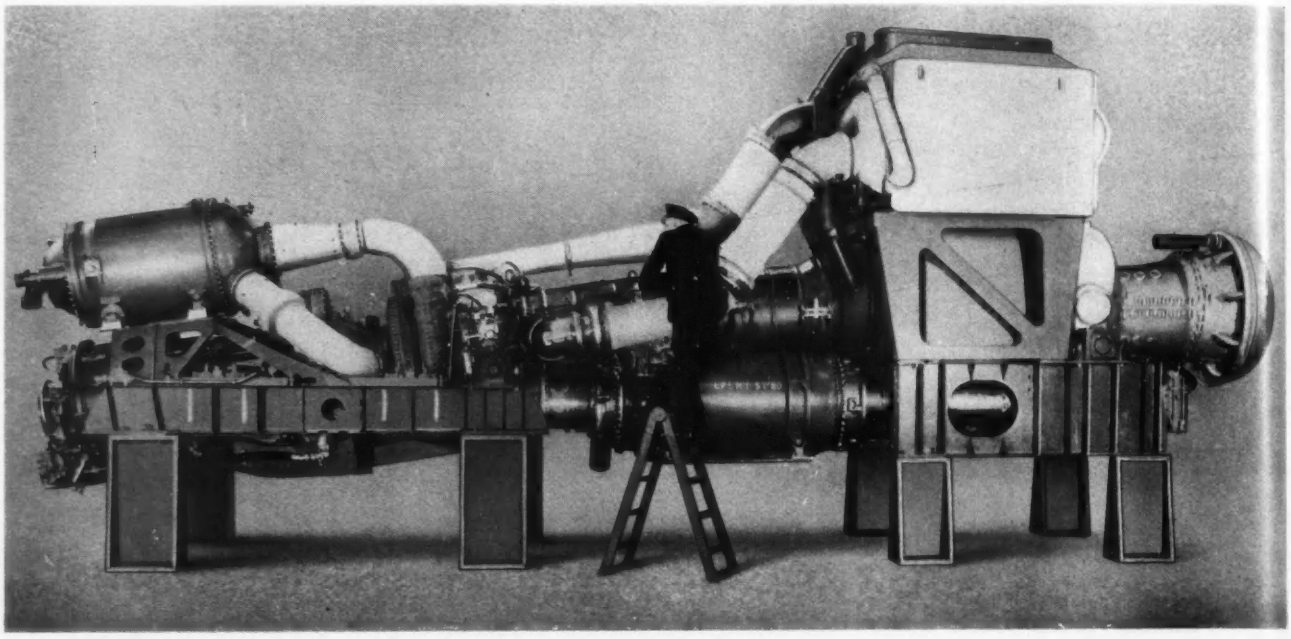


Melting Shop at Lackenby

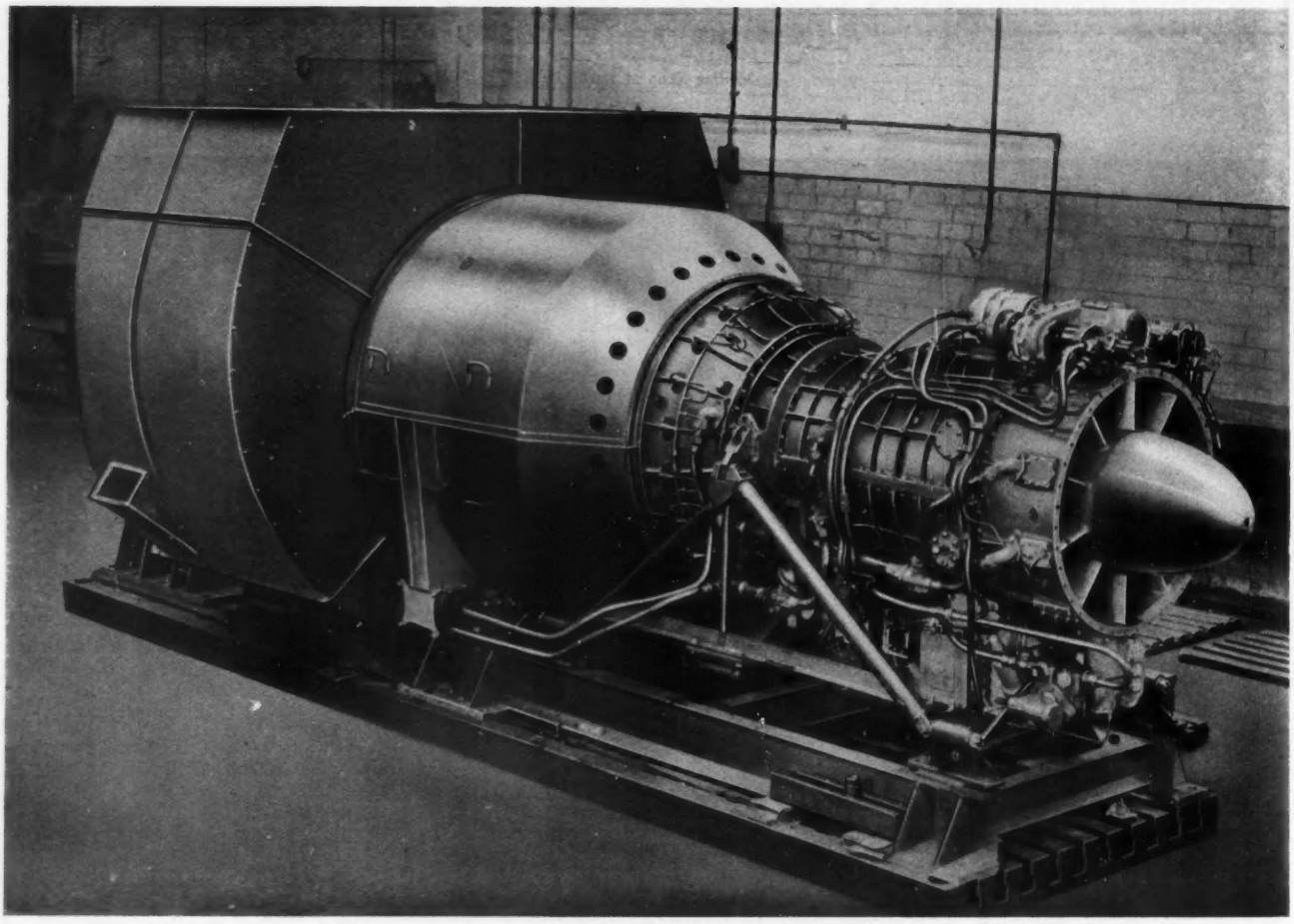


Blast-Furnaces at Shotton

MARINE GAS TURBINES OF 1953



5400 b.h.p. Compound Gas Turbine for H.M.S. "Grey Goose"



4500 s.h.p. "G2" Gas Turbine for H.M.S. "Bold Pioneer"

Shipbuilding and Marine Engineering in 1953

No. I

THE tonnage of steamships and motorships under construction and on order in British shipyards in 1953, although less than the previous year, remained at a substantial total so that it can be said, in general terms, that shipbuilding companies started the new year with full order books and a back-log of ships to lay down. These remarks apply to the broad majority of shipyards, but since all categories of ships are not in the same demand there were some yards not quite so well placed in the matter of orders and their future was not so well assured. However, although the total of the work in hand assured employment for some time to come it cannot be reckoned as the sole criterion by which to measure the prosperity of the industry. The large number of ships waiting to be laid down was to a considerable extent the result of the shortage of steel which continued to be acute and restricted the annual rate of production. Some slight alleviation of the position took place, but supplies were well below the amount capable of being used by the industry.

With regard to employment there were some fluctuations in the numbers engaged in particular trades, but taken overall the level of employment in the main shipbuilding yards was generally maintained. Similar remarks may be applied to the ship repairing industry for the first nine months of the year, but there was a falling off in the numbers employed during the last quarter.

During the first six months of the year the volume of new orders was maintained equal to that of the second half of 1952, but then there was a rapid falling off and the orders received during 1953 were expected to amount to about 150 ships, totalling well below 500,000 tons. The number of ships was approximately half that of those commenced, launched and completed, while the tonnage was only about one-third and indicated that no big ships were ordered. A measure of the drop in new tonnage ordered is given by comparing the total with 1,205,000 tons placed in 1952 and 4,152,000 tons booked in 1951. A study of the foregoing figures shows that although signs of a recession were not lacking in 1952, the returns for 1953 are significant and indicate that the heavy ordering of tonnage of the post-war years has halted. Ships on order for foreign owners remained at about one-third of the grand total on the books of British shipbuilders, which amounted to 5,750,000 gross tons, representing about 900 ships and about £600 million at current prices. At an annual rate of production, as controlled by the supply of steel, of 1,300,000 gross tons, the order book represented full employment for most yards until 1957, a date which would be brought forward should the steel supply position improve.

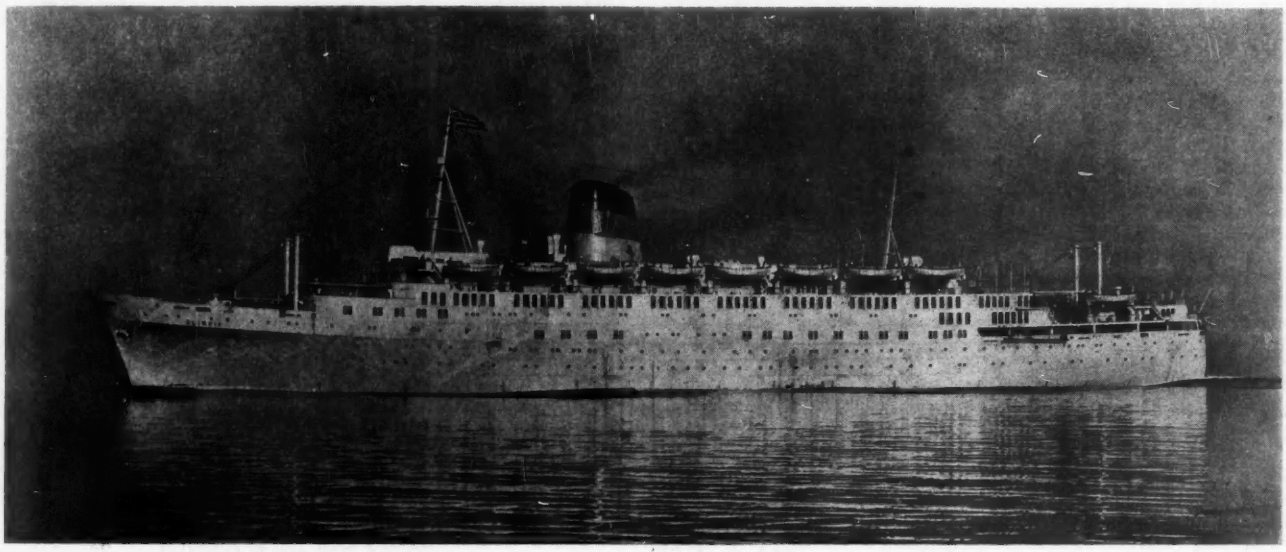
The returns issued by Lloyd's Register of Shipping showed that the general fall in the total of work in hand apparent in the latter half of 1952 continued until half-way through the year. However, by the end of September, 1953, the latest date for which returns were available, the total rose to the highest level since March, 1952, and at 2,190,329 gross tons represented nearly 37 per cent of world tonnage excluding the tonnage building in China, Poland and Russia. Ignoring the variations in the quarterly totals, the tonnage commenced showed an increase, while the totals for ships launched and completed decreased. All the returns showed decreases for the last quarter and this tendency also occurred for ships building abroad and the total for ships commenced declined sharply. But the world totals for the year indicated that there was an increase in the tonnage commenced, launched and completed while the tonnage under construction remained at the same level.

These overall returns for shipbuilding abroad did not mean that the trend was the same in all countries, for in Japan there was a considerable recession, while shipbuilding in Germany steadily expanded and that country advanced to second place among the shipbuilding nations.

Although in the United Kingdom there was a decrease in the total of ships to carry oil in bulk under construction, this class of vessel continued to occupy most of the berths and represented more than half the tonnage under construction, the percentage being nearly fifty-four. However, this high percentage was maintained due to the fact that over 60 per cent of the tonnage building to foreign account was oil tankers. Taking the combined total of the ships under construction and preparing in Great Britain, the approximate division of the tonnage into the main categories showed that the total was made up as follows: passenger and passenger-cargo liners, 7·3 per cent; cargo liners, 24·9 per cent; cargo tramps, 7·8 per cent; oil tankers, 57·1 per cent; the remaining 2·9 per cent consisted of colliers, coasters and others. With this large proportion of tanker tonnage the order book continued to represent an unbalanced building programme so that those yards without oil tankers were in a position to offer quicker delivery dates than those specialising in this class of tonnage.

With regard to the supply of steel, the position was generally comparable with that of 1952 and although the plate distribution scheme afforded some help, the production of ships was limited to about 1,300,000 gross tons, against an estimated maximum of 1,750,000 tons, so that in the last three years Great Britain produced over 1,000,000 gross tons less than capacity. Supplies from Scottish steel mills were disappointing and despite increased steel production the supply of heavy plate was still a bottleneck, although a slight improvement was apparent late in the year. Shipbuilders felt that steel was supplied to other industries which were not users previously, at the expense of the shipbuilding industry and so the industry entered the new year with only the promises of politicians for better supplies.

Costs continued to rise and showed signs of rising still higher since those employed in the industry demanded a further large increase in wages, a claim which was based upon the alleged rise in the cost of living and in the continued belief that the



T.S.S. "Olympia"

additional cost could be absorbed without increasing the cost of ships. However, discounting the possibility of any increase in cost it became evident during the year that prices had reached a level at which they were a major factor influencing the placing of orders. As noted earlier, the heavy ordering of the post-war years is passing and although current orders are a guarantee of work for several years, orders equal to the present annual production rate are necessary to maintain the position. Since June, 1952, the tonnage ordered has not equalled the rate of completion and the orders received during the first three quarters of last year, namely, 170,000 tons, 125,000 tons and 55,000 tons, showed a further decline and as already stated, the total for this year was not expected to reach 500,000 gross tons. The returns available for the twelve months up to September 30, 1952, showed that 310 ships of 1,858,000 gross tons were ordered and the comparative figures for the same period up to September 30, 1953, were 166 ships of 510,000 gross tons and indicated the extent of the decline.

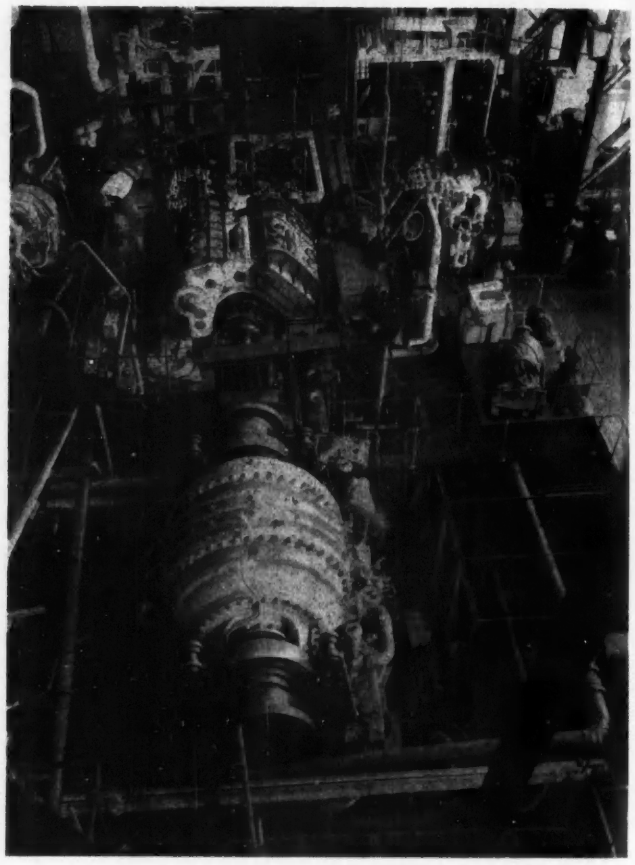
Since the war the Continental shipyards have steadily repaired damaged buildings and replaced equipment to become highly competitive and our percentage of world shipbuilding has fallen from 60 per cent in 1946 to under 40 per cent last year. Germany in particular has made considerable headway and as a measure of her advance, Germany commenced almost as much tonnage as Great Britain in the third quarter of last year. Several factors afforded reasons for this rapid change. The German workman is prepared to work longer hours and perhaps what is more important is that demarcation of work is not allowed to cause delays and simple jobs, normally belonging to one trade, are done by the man on the spot to save wasteful standing-by time. Such a policy makes for efficiency, and it is evident that British shipbuilding cannot achieve the same degree of efficiency, with a large number of trade unions having rigid demarcation rules. The readiness to work shifts and overtime resulted in a speed up of delivery, a factor which diverted a number of orders to Germany and balanced any price advantage in favour of Great Britain. Even this small margin tended to dwindle, since the price of German steel tended to fall and this, coupled with the willingness of Germany to quote fixed prices against our cost plus an escalator clause may well be decisive in obtaining orders in an industry becoming more highly competitive. In Japan there was a recession in the tonnage under construction generally due to the higher prices in that country, but vigorous action was being taken to increase competitive power.

There were indications in 1953 of a recession in world shipbuilding so that competition for orders is likely to become keener in the present year, and while we exported approximately 30 per cent of our production, Germany exported about 60 per cent, the respective amounts for the Netherlands, Sweden, Belgium, France and Japan being 70 per cent, 45 per cent, 64 per cent, 29 per cent and 30 per cent. No doubt the continued shortage of steel slowed down British shipbuilding and so increased costs, since the capital cost of the reconstruction programme, which has been carried out in a large number of yards, had to be carried on a productivity level restricted to considerably less than the maximum, coupled with the shorter working week. The need for more steel plate is urgent, for if larger supplies are delayed then the steel may arrive when it is too late to prevent orders going abroad. A factor which will help British shipbuilders is the recent announcement that loans are to be easier to obtain and the terms of repayment less onerous. Up to the time when this statement was made by the Chancellor of the Exchequer, late in December, other industries had been given credit for seven years while shipowners had been allowed six months in which to repay a loan. It was impossible to do this out of a ship's earnings so that foreign owners had begun to turn to other countries where facilities are more favourable and, indeed, many countries are resorting to artificial aids, special financing and long-term credit, to attract orders. To offset these advantages offered abroad perhaps, under the new arrangement, the lending powers of the Ship Mortgage Finance Company, Ltd., could be extended and greater access to the bill market granted in order to attract more orders from British and foreign owners.

Shipbuilding depends for full order books upon the prosperity of the shipping companies, which in turn is governed by the volume of multilateral trade. With world competition getting keener owners were more than ever concerned at the increasing cost of new ships, and many leaders of the shipping industry emphasised that the high cost of new tonnage was discouraging. The price of an article is the major factor in deciding the ability to sell or export, and earnings in shipping are keenly sensitive to the rise and fall of freight levels and it was pointed out that it was impossible to buy ships at prices which would result in an operational loss. Some owners bluntly stated that they were forced to call a holiday in the ordering of ships since in their judgment present costs would cause freight charges to be pushed up to a point where shippers would not ship and, therefore, the ship would not pay. Other shipowners considered cancellation. They denied that this was a political manœuvre and maintained that it was a straightforward consequence of economics since price must be linked with probable earnings. To-day the shipowner has to undertake all the hazards of the instability of final costs since the shipbuilders found fixed prices to be expensive. This possibility of cancellation was not welcomed by shipbuilders since many owners had had the benefit of fixed prices, to the shipbuilders' disadvantage, at an earlier date.

Besides first cost there is the question of the crippling taxation, levied on the industry, which has made it impossible to carry out a programme of replacements necessary to maintain the efficiency of the fleets let alone any policy of expansion. The weight of taxation is such that it is impossible to supplement the depreciation allowed for tax purposes out of taxed profit and if the industry cannot provide for its own survival there is little possibility of attracting capital at risk. The continuance of unrealistic taxation must lead to the shrinkage of tonnage under the British flag and that this is happening has been borne out by the shrinkage of the percentage of world tonnage owned by Great Britain from 50 per cent in 1905 to 32 per cent in 1925, to 27 per cent in 1937, and to 20 per cent in 1953. Concern was expressed by owners at the effect of taxation on tramp shipping, which was at 2,400,000 gross tons last year, or 1,000,000 tons less than in 1939. With the index of tramp shipping freights at about seventy-four compared with 100, representing 1952 as the basis year, the possibility of tramp owners placing orders at current prices was remote. Lack of coal was the tragedy of this class of tonnage and had resulted in the increased cost of bulk imports, since the old order of coal outwards and bulk cargo inwards no longer obtained. Depreciation based on first cost, when the cost of replacement may be three to four times the original price, is completely unrealistic.

Leaders of the industry voiced the opinion that shipping should have special treatment and that our legislators should realise that ships cannot be replaced in annual instalments but that the ship is itself the unit of replacement. This position, it was maintained, coupled with the fact that payment for new ships is made at various specific stages of construction and involves considerable loss of interest until the ship is in commission, called for a particular fiscal policy for shipping, Such a scheme should not be beyond the powers of tax legislators



Machinery under Test at Pametrada

to encompass and Lord Teynham suggested recently, in the House of Lords, that a fund should be created solely for the purposes of fleet replacement, from specially allocated untaxed reserves. He pointed out that our shipping services had contributed £225 million to the country's foreign exchange in 1952. The size of this contribution to the balance of payments, he urged, was in itself a sufficient indication of the necessity of maintaining the efficiency of British shipping by ensuring that the owners had adequate resources to finance fleet replacement programmes.

Research and Development

Research with regard to ship hull form, problems of strength and constructional technique and the development of marine engineering practice and design, was continued during the year by the British Shipbuilding Research Association and Pametrada, and every endeavour made to reduce the time lag between the establishment of scientific fact and its practical application.

The fifth report of the B.S.R.A. was published during the year, covering the period from April 1, 1950, to March 31, 1953. It gave an account of the general activities of the Association as well as a detailed statement of the progress of the various items of research work. Over the period covered by the report the members received sixty-two research reports and thirty technical memoranda while some twenty-nine papers concerned with the work of the Association were read before the technical societies. The papers presented last year numbered eleven and referred to a number of subjects representative of the work carried out by the Association and served to bring to the notice of those engaged in the technical side of shipbuilding and engineering the results of investigations into specific problems. It is the policy of the Council of B.S.R.A. to give wide publication of much of the work and this policy has enhanced the scientific standing of British ship design and construction abroad. As illustrating this interest in research among foreign shipbuilders, Dr. Livingston Smith, the director of research of B.S.R.A., was invited to read a paper on the organisation of B.S.R.A. before the Royal Swedish Academy of Science.

Members have received the results of the resistance and self-propulsion tests on a further methodical series of models of ocean-going vessels and this work proved of value to ship designers in the production of more efficient hull forms. The tests involved a study of the variations of the position of the longitudinal centre of buoyancy ; the breadth/draught ratio ; the length/displacement ratio ; the propeller diameter ; and an investigation was made into the effect of the bulbous bow. More specialised craft such as trawlers, tugs, coasters, dredgers and hopper barges were also studied in similar fashion and a decision, which was taken, that in future models will be run with trip wires only is expected to expedite the work. A method of producing forced pitching in models with a view to producing the best forms for seaworthiness engaged attention and an apparatus which was developed and constructed at the tank of John Brown and Co. (Clydebank), Ltd., underwent proving tests before being applied to a programme of research.

A paper with the title " B.S.R.A. Resistance Experiments in the ' Lucy Ashton ' " was read at the Spring meeting of the Institution of Naval Architects by Dr. J. F. C. Conn, Mr. H. Lackenby and Mr. W. P. Walker. This paper, an abstract of which was published in The Engineer on March 27th, April 3rd and 10th of last year, analysed the results of the resistance trials to establish ship model correlation for naked hull conditions and extrapolation was made on the basis of the Schoenherr, Telfer, Prandtl-Schlichting lines and the Froude method. Since the reading of the paper, which aroused international interest and stimulated other work, the analysis of the results has been completed to include appendages and a report issued. The papers on the " Lucy Ashton " stressed the importance of the effect of hull roughness upon resistance and further work was done on this problem, including an investigation on the effect of butts, laps, rivets and weld beads.

The general objective of the work on structures was to gain information about the strength and efficiency of the structure and structural components of a ship, the properties of the various materials used and the efficiency of riveting and welding. Much of the work was done on scale models and the reliability of the techniques employed was confirmed by full-scale work. One of the items was the determination of loads, stresses and deflections in ships' structures, and work on thin-walled steel box girders was carried out at the Imperial College in London. Comparative calculations, by various methods, of the transverse strength of ships were made by the Association's staff and a testing frame for making pilot tests on transverse strength was constructed in the laboratory at Palmers Hill, Sunderland. Compression tests on riveted and welded double-bottom structures were carried out by the staff of Lloyd's Register of Shipping, and this association of Lloyd's Register with B.S.R.A. on the structural tests, with the staff of the Registration Society undertaking many of the investigations, is significant as it is only through the rules of the Society that the results of the experimental work can be applied to practical shipbuilding.

Launching problems continued to be studied during the year and at the Mechanical Engineering Research Organisation at East Kilbride tests on greases were carried out, while measurements were taken at launches of the creep of the ways prior to the release of the trigger. At the Autumn meeting of the Institution of Naval Architects in Holland the results of the investigation into the frictional properties of launching greases were given by Mr. J. Brown and Mr. J. M. Ferguson in a paper entitled " Tests on Launching Greases." Other findings of the research into launching problems were in preparation for a paper to be read before the North-East Coast Institution of Engineers and Shipbuilders.

At Glengarnock the testing station proceeded with tests on full-scale and the work included light alloy specimens, and associated with the latter, cold working tests were carried out on special bulb angle and channel sections at the yard of Alexander Stephen and Sons, Ltd. Tests related to the watertightness of riveted aluminium alloy joints and to caulking were carried out by J. Samuel White and Co., Ltd. A series of flat plates was tested at Cambridge University to obtain information on stress distribution under axial and lateral loading and a report was issued on the testing of an unstayed mast with a 40-ton derrick.

On the question of the causes and prevention of corrosion the British Iron and Steel Research Association collaborated with B.S.R.A. and a programme of corrosion tests in sea-water on welds in mild steel plates was arranged and some seventy-five specimens were suspended from a testing raft at Caernarvon to remain there for one year.

The development of steam and gas turbines falls within the province of Pametrada, and therefore the work of B.S.R.A. is directed to the gradual improvement of well-tried designs of engine. The Association worked with the British Ceramics Research Association upon the question of brick and brick bolt materials and data was obtained upon performance at sea. Some progress was made in the analysis of the early data obtained in service and the recording equipment used was calibrated in the laboratory of the British Ceramics Research Association.

Work proceeded upon the natural circulation in water-tube boilers, at the Royal Technical College, Glasgow, the effect of heat input rate upon natural circulation at pressures up to 1500 lb per square inch being investigated and a theoretical investigation made into the optimum thickness of tubes for water-tube boilers. The results of the work have been embodied in a paper to be read before the North-East Coast Institution of Engineers and Shipbuilders. To eliminate the nuisance of the descent of funnel gases on to ships' decks, a research item of interest to shipowners, a programme of work was drawn up including tests on models and on full scale to determine the influence of the superstructure. Wind tunnel tests were carried out on the models in conjunction with Thermotank, Ltd., and in the early stages much of the work was designed to test the reliability of the techniques employed and as a check observations were taken on vessels at sea. To date the correlation between model and ship has proved satisfactory.

The machine for studying oscillating bearing behaviour was used by the Mechanical Engineering Research Laboratory for an experimental investigation of the conditions obtaining in top end bearings of steam and diesel engines. Experimental work with the two single-cylinder diesel engines was commenced and reports of previous research were prepared. An investigation was put in hand into the pressure variation in the scavenge belt, cylinder and exhaust pipe of a marine diesel engine during the scavenging period, and during the year a number of indicator cards were taken on a number of engines on test beds using the modified Farnboro' indicator, which was fully described in The Engineer of July 4 and 11, 1952. Work connected with crankcase explosions was advanced further and tests with condensed mists started, while progress was made with the work on the ignition and burning characteristics of large oil droplets. A report was prepared covering the work at Sheffield and Nottingham Universities upon the failure of diesel engine components exposed to combustion and included fatigue tests at atmospheric and elevated temperatures, thermal shock tests, and dilatation tests. Further work was in hand on the fatigue and creep properties of cast irons at elevated temperatures. Work on the expanding of boiler tubes at the Imperial College was well advanced and an apparatus was made which shows the build-up of the strains and mandrel torque during the expansion of a joint.

Investigations into the fatigue strength of engine shafts was continued and a paper entitled " Investigation of the Effect of Fillet Radii on the Torsional Fatigue Strength of Marine Shafting," read by Mr. T. W. Bunyan and Dr. H. H. Attia before the Institution of Engineers and Shipbuilders in Scotland, gave the results of tests on a shaft

of 9¾in diameter carried out by Lloyd's Register of Shipping for B.S.R.A. The Royal Technical College and Lloyd's Engineering Research staff worked, in conjunction with B.S.R.A., upon the preparation of a programme to investigate the methods of securing propellers to tailshafts. The first-named arranged to take measurements in engine shops, while Lloyd's arranged to carry out tests on a fatigue machine. Corrosion of propellers and propeller shafting was another subject for research and an early investigation showed that copper alloys can become electro-negative to steel in water having a high sulphide content.

In the field of vibration the B.S.R.A. went forward with a programme of work intended to put designers of ships and machinery into a position such that this nuisance can be anticipated and avoided. A vibration exciter lighter than that previously used was designed and construction put in hand in readiness for a programme of work on board ship, meanwhile the staff of B.S.R.A. attended many trials to take vibration readings and were called in to give advice where bad vibration had occurred. These activities had the dual advantage of giving immediate and practical assistance to members while adding to the Association's data with which to check the theoretical solutions to the vibration problem. At the Vickers-Armstrongs tank at St. Albans experimental work was put in hand to investigate the forces involved in propeller excited vibration in a wooden model hull. Reports were issued with regard to the determination of hull vibration frequencies and Mr. A. J. Johnson and Mr. W. J. Marwood read a paper with the title "Vibration Tests on an Up River Collier with Special Reference to the Influence of Depth of Water," before the North-East Coast Institution of Engineers and Shipbuilders. Calculations were made on the loading of the shafting bearings of a 17,000-ton tanker and the results given as a technical memorandum.

With regard to ships' performance the Association constructed new autographic recorders, for use on measured mile trials, which continuously record shaft revolutions per minute and relative wind speed and direction and in addition a roll and pitch recorder was developed. For the measurement of hull roughness special gauges were produced and another gauge for use on propeller blades was under development. The analysis of trial records continued to rank high in importance and members of the staff attended more than thirty trials during the year.

Under the guidance of its director, Dr. T. W. F. Brown, Parsons and Marine Engineering Turbine Research and Development Association continued and expanded the research programme and greatly increased its fund of knowledge. No new buildings were completed during the year, but the aerodynamic and combustion laboratories were in full operation and a start was made on the new administrative block. The design staff was engaged in the preparation of more detailed drawings for foreign licence holders and gave consideration to engine-room auxiliaries. Included among the designs was one to operate normally at 14,000 s.h.p. on a single shaft, but with a large reserve of power, and also oil tanker machinery of 12,000 s.h.p. normal rating using steam at 600 lb per square inch and 950 deg. Fah. Work was completed on a scheme for a new turbine cylinder joint and a design prepared for a small emergency turbine intended for single-screw ships having single-cylinder turbines. Progress was made with the machine for grinding helical gears and basic plans of a machine to grind wheels between 30in and 90in diameter were completed.

The Steam Turbine Research Department continued with the trials of "Y.100" anti-submarine frigate machinery and completed 496 hours of steaming. Three different gearcases were used and a number of lubricating oils tested, while noise and vibration measurements were made and analysed. Preparations were made for the trials of a further prototype set of naval machinery "Y.E.A.D.I.," and for experimental work in connection with noise reduction of admiralty machinery. A number of investigations were undertaken on board H.M. ships, during which airborne and structure borne vibration was measured from main and auxiliary machinery and an investigation on the "Y.100" blower with various forms of silencing was completed. To provide experience with high-temperature steam at high pressure and to study the performance of special materials, particularly the effect of thermal stressing, an experimental unit "Pamela" was designed and built. The unit is a six-stage impulse turbine representing the high-pressure cylinder of a three-cylinder turbine developing 3000 s.h.p. and passes 30,000 lb of steam per hour at 1100 deg. Fah. and 1100 lb per square inch to develop 1650 s.h.p. at 8900 r.p.m.

Work on marine gear testing continued by the back-to-back method, recent trials included double helical, single-reduction gears of steam gunboat pattern and work in hand had for its object the obtaining of data upon the performance of various combinations of gear steel and tooth forms under service conditions. Other back-to-back gear tests included tests to destruction of "S.G.B." gears and experiments with a set of Avgra hardened and ground gears, which were tested up to 18,000 h.p. on one flank and 26,000 h.p. on the other. Noise and vibration measurements were taken and the effect of oil temperature and viscosity on the total noise investigated. In the hope of eventually saving weight and space an experimental condenser was designed for carrying out experimental work to fill in gaps in existing knowledge. Other items of component research touched upon vibrations in impulse blading, expansion joints, the testing of furnace fuel oil pumps. The programme of journal research on the effect on performance of various L/D ratios went forward and also experiments on the determination of temperature distribution.

(*To be continued*)

Aeronautics in 1953

No. I

THE celebration of fifty years' flight came upon the world of aeronautics at a time when it looked less with astonishment at its past than with bewilderment towards its future. Its evolution had been remarkable enough without any impetus from the jet engine. Yet, who of those who lived at the turn of this century and who since have laboured in its cause can fail to acknowledge that with the coming of the jet motor family there has been drafted, urgently and convincingly, a new evolutionary curve to include interplanetary flight itself. With such prospects the seemingly giant steps of yesterday, its most ambitious schemes and aspirations, now seem completely dwarfed. Metallurgical problems there are, no adequate fuel is yet available, nor is the manner of propulsion settled, and many lesser problems, when compared with these must abound. But such are the tools and the intellects now mobilised within the vast boundaries of its researches that there is about none of these problems that air of insolubility which with common prudence could suggest the advisability of seeking a lesser objective.

Much has been written and recalled in the last few weeks of those early days of flight. In this country perhaps the most notable contribution has been the account by J. Laurence Pritchard, entitled "The Wright Brothers and the Royal Aeronautical Society: A Survey and Tribute," which is contained in the December *Journal* of the Society, and his address, "The Work of the Wright Brothers for Aviation," given before the Royal Society of Arts on December 16th. In America, the papers of Wilbur and Orville Wright have just been published under that name by the McGraw-Hill Book Company, which tell their remarkable story in its entirety for the first time.

It is a remarkable testimony to the Wright Brothers that, in spite of the many problems which have since been solved and the more recent distinguished solutions to problems more complex than those the Wrights encountered, the aeronautical world should pause almost spontaneously to honour their genius and intuition. For it is not so, simply because they were the first to fly—eventually somebody was bound to integrate the requirements correctly of what before them had already been declared an inevitable event. The merit of their contribution is more properly appraised when the cold and dispassionate theoretical and flight development programme they adopted is examined. It has also to be borne in mind that the Wright Brothers had little technical education and very restricted financial resources. Yet largely in their own time and during holidays from their cycle business, in a period of three years, they assimilated what theoretical and applied science had already been evolved, perused the data published by men of more orthodox learning—much of which they subsequently rejected—and on applying their knowledge and beliefs adopted tactics in which the worst combination of circumstances would not greatly have disturbed their progress.

The philosophy and decisions which most clearly emphasise the superiority of the brothers' contribution over their contemporaries became evident very soon after their interest was aroused on this problem in 1899.

First, they jointly declared that man would never fly, as was then earnestly believed, by mechanically reproducing the lift generating properties of birds. Secondly, what might be emulated from these creatures was their method of control, and so it was that in 1899 they constructed a biplane kite such that they could warp its wing tips differentially to obtain lateral control in the manner of bird flight and translate the upper plane bodily forward to obtain longitudinal control which was similarly analogous to the forward movement they had observed of birds' wings when hovering. They manipulated these surfaces by cords from the ground. The brothers were aware that the major problem of all researchers was that of obtaining

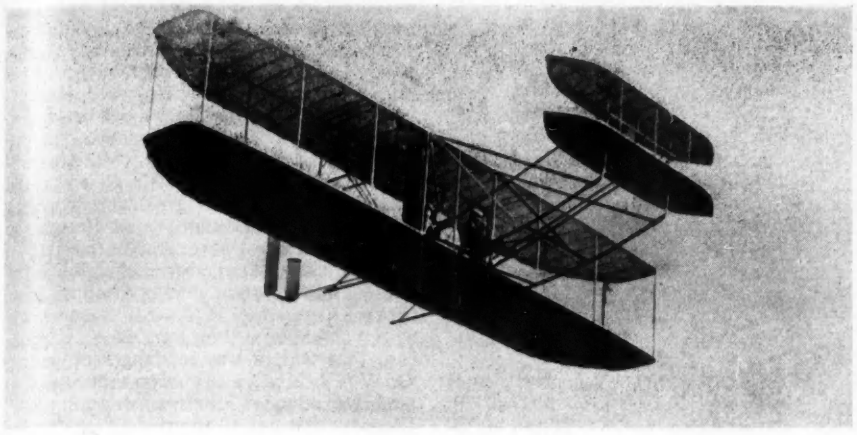


Fig. 1—A Wilbur Wright Biplane

equilibrium, the loss of which had so often proved fatal. Where it had not proved fatal it made flight arduous and the accumulation of data on other aspects of the machine in flight unreliable.

Armed by the experience with this kite that their conception of control was the right one, they then commenced their development of full-scale man-lifting biplane gliders, which they could either fly as kites tethered from the wing tips or in full piloted flight but in close proximity to the ground. The first, in 1900, had a wing area of 165 square feet, and all of them had an elevator mounted forward from outriggers. The following year they returned to Kitty Hawk with a larger machine of 290 square feet. It flew very disappointingly, and tests made upon it clearly confirmed the gross inaccuracies of Lilienthal's aerofoil data, which had been noted on the first glider. Whereupon they decided that year to institute their own investigation into the properties of model aerofoils, first using a contraption mounted on the handlebars of a bicycle and soon afterwards a wind tunnel—the first of its kind—was used, when it was evident that a more refined technique was essential for the smaller angles of incidence. It consisted very simply of an open-ended box, a small 2 h.p. fan and an arm on which two models were made to balance in the air stream. This was followed by a larger and much improved tunnel and balance, on which concluded a systematic investigation on a series of some 200 metal aerofoils having an aspect ratio now accepted as standard and including other investigations on the effect of plan form, aspect ratio, and gap chord ratio.

Dr. Lewis, in his Wilbur Wright Memorial Lecture in 1939, which revealed some of this data for the first time, included this comment : "This is indeed a surprising research programme for the year 1901. I wish to emphasise particularly the broad fundamental point of view it shows. So clear was the Wright Brothers' appreciation of the basic factors in the problem that they included all but one of the important variables that have since concerned us in wing and aerofoil research. In this respect most subsequent research along this line appears mainly to have been in extension and experiment of its basic outline. Since it was never published, the research programme clearly bears the independent approval of eminent research scientists in this field, who have almost universally employed the same method of attack. . . . The question of translating the recorded measurements into forces effective on a full-scale machine is the crux of the whole situation, and in this respect the Wright Brothers revealed not only considerable understanding of mechanics, but an astonishing appreciation of the pitfalls involved in small-scale wind tunnel testing."

And so this astonishing programme, outstanding alike in its contents, its order and its accuracy, approached its climax. Yet it was with their third and last glider, modified as a result of model tests and slightly larger (305 square feet), and notwithstanding the confidence and skill gained from many hundreds of flights, that they had the first accident—a stall from 30ft, so often fatal, and the very circumstance which they had endeavoured to avoid throughout the programme. Orville escaped and in the repaired machine a rudder replaced the original two fixed vertical surfaces and was interconnected with the wing warping mechanism. Very satisfied with this craft, the brothers finally made known their need for an engine with a specific weight lower than that which was then acceptable. It needed to develop 8 h.p. and to weigh less than 200 lb. They received no response so they designed and made one themselves with the aid of a machinist and completed it within six months. It developed 12 h.p. at 1020 r.p.m. take-off and weighed 152 lb. Although the specific weight, 12·7 lb/h.p. compares with the figure of less than unity for some in-line engines of the last war, it was nevertheless a remarkable engine compared with contemporary automobile standards. It was a flat four-cylinder, water-cooled engine with a stroke of 4·25in, bore of 4in and swept volume 335 cubic inches. The crankcase was made of aluminium ; it had screwed cylinder liners and employed a vaporising direct injection fuel system.

In preparation for this last phase of their experiment the Wright Brothers built a new machine similar to their last glider. It was fitted with twin tractor propellers of their own design, contra rotating, each driven from the engine by a bicycle chain. The weather was unfavourable on December 17, 1903, a strong wind of 27 m.p.h. prevailed, and it was bitterly cold. At midday and tired of weather delays, Orville mounted the machine and with Wilbur steadying one wing tip the machine travelled forward along its monorail, to become airborne for twelve seconds. It had travelled at 31 m.p.h. Three other flights were made that day, the longest of fifty-nine seconds. It sustained slight damage during the last flight and before repairs could be effected it was partly wrecked on the ground by a gust of wind. Of its performance Wilbur wrote that their calculations had worked out with absolute correctness. The machine which the Wrights demonstrated in Europe is illustrated in Fig 1.

The whole story of this period has only just been told. It was only natural that the brothers should wish for due recognition of this achievement and its protection by patents before publishing their researches, but in so doing they sadly frustrated that event. In the account to which we have referred is given the full and somewhat incredible details of the Langley controversy, which was not finally resolved until 1942.

The subsequent development of aviation is better known. In the case of one typical British firm it is depicted by our illustrations of the first and the most recent aircraft to be made at Filton, the Bristol " Boxkite " of 1910 and the Bristol " Britannia." Aviation owes its evolution largely to its potentialities in war and it underwent its major transformations during two world wars. To-day the astonishing pace of evolution is still primarily dictated by military expedient, but it is also, though perhaps incidentally, nurturing man's greatest ambition—the achievement of interplanetary flight. These two objectives are perhaps separated only by a detail in the construction, shown in our illustration, of what is called a guided missile development carrier—the contents of the head.

It may be that the attraction and the promise, however distant the latter may be, of interplanetary flight will bring about co-

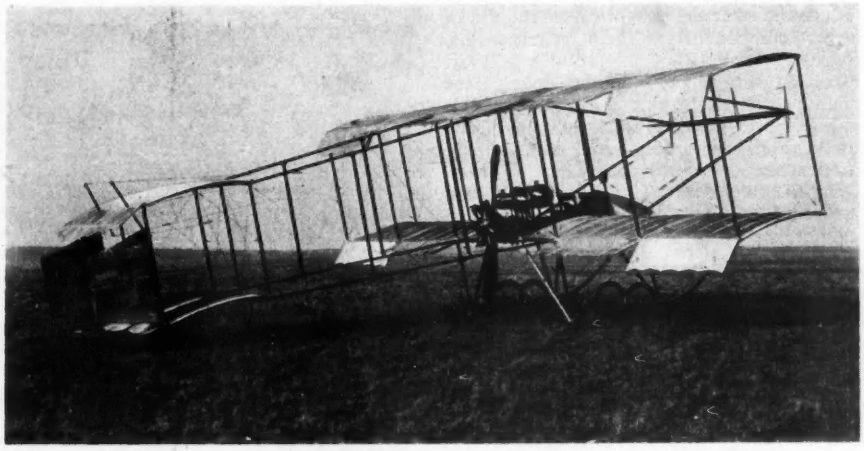


Fig. 2—The Bristol " Boxkite "

Fig. 3—The Bristol "Britannia" Airliner

ordination of the available resources of the whole world upon its attainment.

Civil Aviation

Even if the realisation of supersonic passenger transport be dismissed as a prospect too distant to concern us for many years, there are still left many problems affecting the design and production of high subsonic aircraft. There has arisen a basic conflict between design and production requirements and the issue which exists with civil aircraft is not so much how fast they can be designed to fly but how fast they can afford to fly. The thin high-speed swept wing demands a wing of integral skin web construction, making obligatory three dimensional milling to close limits on panels up to 80ft long, and the imperative need to reduce the structure weight forces the use of larger components. These requirements, together threaten to revolutionise aircraft manufacturing methods and to involve the manufacturer in the purchase of large profile milling machines and of forges of up to 50,000 tons capacity at prodigious cost. A forge in America of 35,000 tons capacity, 118ft overall, and weighing 9000 tons, has been estimated to cost £2,250,000, and the cost of milling machines there between £100,000 and £150,000.

These trends in design and manufacture were again the theme for the annual conference arranged by the Institute of Production Engineers at Southampton last month. The figures quoted above were given in the paper read by S. P. Woodley, of Vickers-Armstrongs, Ltd., on production trends, which was abstracted in The Engineer, December 25th.

The advantages claimed in America for integral wing construction and the use of larger integral sub-components, where the policy is becoming well established, are impressive. For the former it has been stated that wing panels can be made up to 20 to 50 per cent more cheaply and much more quickly.

Whether or not a firm can justify the capital outlay for such tooling is quite obviously dependent on the number of aircraft likely to be required and equally important in this transitory period whether such highly specialised machine tools can be designed to be sufficiently flexible to accommodate subsequent dimensional modifications to the aircraft. America, it seems, is already prepared to commit herself to this form of wing, which involves mounting the engines and fuel externally in pods, for both civil and military jet aircraft. The case for this configuration was presented by C. S. Schairer, of the Boeing Aeroplane Company, in a paper read before the Anglo-American Aeronautical Conference last year and abstracted in our issue of September 25th.

In this country, there are, apart from the "Comet," three wing profiles under evaluation for bomber aircraft. A design specification for a civil version based on the wing section of each of these has been prepared. That for the "Vulcan" delta version was described in The Engineer of June 19th. They have in common a large root chord, enabling the engines to be housed within the wing profile without giving anything in thickness/chord ratio, the delta being an extreme case. The need from purely geometrical considerations for integral reinforced skins is less with these configurations, but the extent, if any, of its application in these designs cannot be disclosed. That it is being investigated at least is apparent both from the exhibits of typical wing panels at recent Farnborough exhibitions, and from the paper to which we have already referred, in The Engineer, December 25th, which described some current development work at Vickers-Armstrongs, Ltd. Several speakers at this conference, however, expressed concern that Britain was in danger of getting seriously behind in this important aspect of aircraft production. It is worth noting here, however, that not all the current production problems in this country are inherently necessary, for the discussion echoed a conviction manifest at the 1952 conference that much could be gained if designers knew a little bit more about production and production engineers were a little more appreciative of design problems.

Another development reviewed at the conference was the extension of the use of "Redux" bonding in this country as an alternative to riveted construction, and in the case of the wing, to integral panel machining, and mention was made of the tapered rolled skins being made in France.

Even the stabilising of design and production for such 600 m.p.h. civil jet aircraft as are envisaged above is threatened by yet two further factors. Probably the more imminent of these is the impact which titanium might have were suitable alloys to become available in sufficient quantities. One of the papers read before the Royal Aeronautical Society last year, that by P. L. Teed, "Titanium—a Survey," much of which was abstracted in The Engineer, February 6th, examined the prospects of this development. Already in the United States pro-

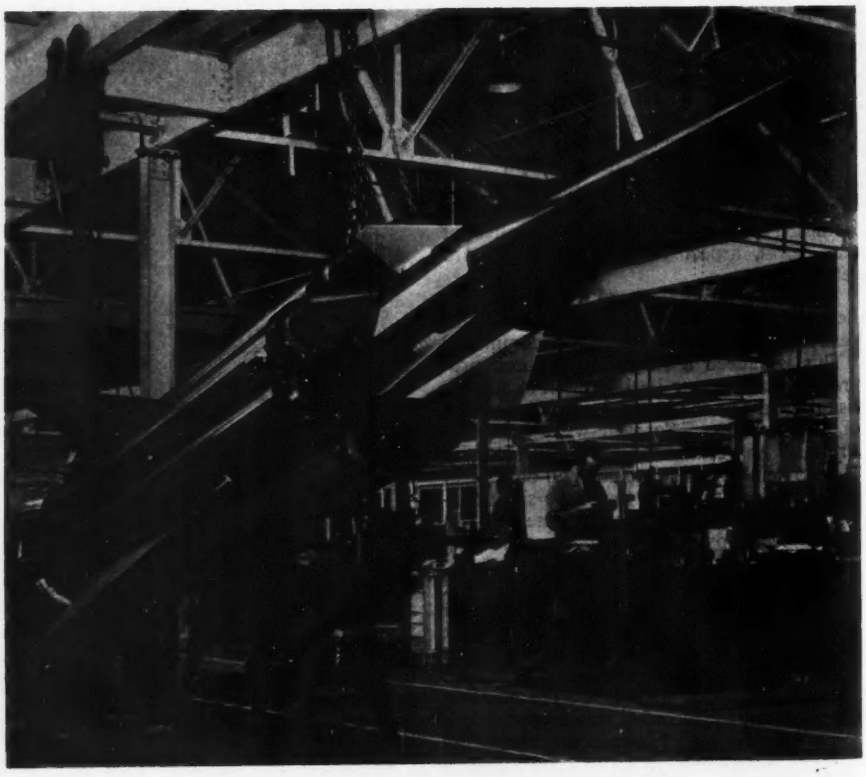


Fig. 4—Armstrong Whitworth Guided Missile Test Vehicle

duction of titanium is reported to be approaching 25,000 tons per annum, although here a figure of 25 tons has been quoted.

The other factor to which we referred concerns recent developments in this country in boundary layer control, about which strict secrecy is being maintained. This is a method of increasing the stability of the laminar boundary layer by making the aircraft surface either porous or perforated, and thence sucking air through it from without.

Sir Frederick Handley Page, in commenting on this development, recently stated that the introduction of jet propulsion had led to a new design philosophy which aimed at the integration of propulsion and lift production.

Sir Frederick went on to explain this new philosophy, as follows :—

"The conception of the motorised glider dominated aircraft design as long as piston engines formed the propulsive unit. We had, therefore, during this phase, a distinct dualism between propulsion and the purely aerodynamic, i.e. lift or circulation producing elements, namely, wings. Change of circulation or lift was sought exclusively by change of aerofoil characteristics.

" The results of basic research done so far indicate that substantial improvements of performance, due to drag reduction or lift augmentation, can be obtained through the by-passing of power to control the boundary layer or the circulation and, hence, the lift of the wing. Alternatively, the whole problem of take-off may be revolutionised by the incorporation of jet thrust into the lifting system. Eventually we may even come to the stage where the power units are used to remove the wake produced at the source of its production on wings and fuselage, leaving only a small modicum of power required at cruising to overcome induced drag.

" Developments such as these will affect design even more profoundly than the introduction of metal construction in the 'thirties. The dualism between propulsion and lift production, which has existed for so long, is vanishing and we are moving towards an integration of both régimes."

One further development reported this time from France is the use at the Louis Breguet works of prestressed concrete wings on guided missile and fighter aircraft. The wing consists of a stressed skin with a longitudinal web. The concrete is composed of special cement and porphyry granules and is stated to be four or five times as strong as ordinary concrete. The Freyssinet system of prestressing is used. It is said to weigh no more than a conventional wing, that it can be made as accurately, more simply and more quickly.

(To be continued)

Gas from Oil Plant

SINCE the war the high quality coals necessary for gas-making have become more difficult to obtain and in general coal has become scarce and increasingly more costly. This position with regard to the supply of the traditional basic fuel, coupled with the fact that in 1945 to 1947 the existing gas making plant did not have sufficient capacity to meet the demand, caused the gas industry to endeavour to use oil as an alternative for coal in the plant available. As a result of work in the central laboratories of the former South Metropolitan Gas Company catalysts were discovered which could so control the reactions between steam and heavy oil that gas, similar in composition to ordinary town gas, was produced from the heavy oil. This development formed the subject of a paper read by H. Stanier and J. B. McKean before the Institution of Gas Engineers in 1950. Further work, carried out in the same laboratories, demonstrated that the same catalyst materials are suitable for reforming refinery tail gases and methane, which is a constituent of natural gas, and of fire damp, and which is now being taken from the mines to augment town gas supplies.

The original gas company continued the experiments to produce a pilot plant and, in nationalisation, the South Eastern Gas Board gave every encouragement to the project. Eventually a large-scale unit was installed at the Old Kent Road gasworks and this served to resolve the practical difficulties in expanding a laboratory process to production at a commercial level. From this point work proceeded in collaboration with the Power Gas Corporation, Ltd., of Stockton-on-Tees so that the practical experience of this company in the design of gas-making plant was allied with the accumulated knowledge of the new " Segas " process to produce a suitable plant. As a result a prototype commercial unit was designed jointly and installed at Sydenham early in 1953. At present the installation, which we visited recently at the invitation of the South Eastern Gas Board, is producing 800,000 cubic feet of gas of standard quality per day and effecting a daily saving of 60 tons of coal.

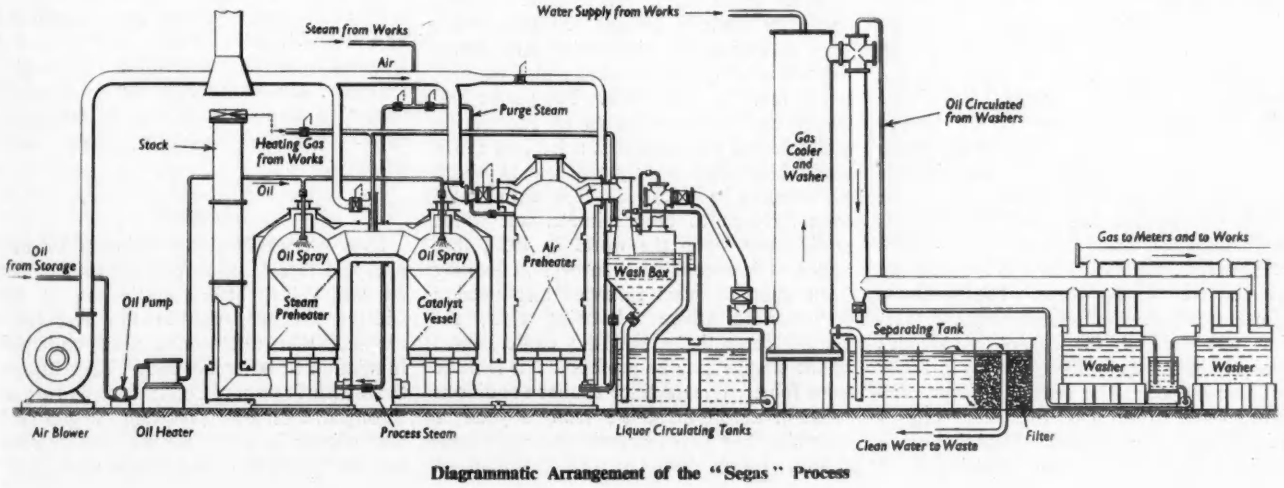
Since the petroleum hydrocarbons, in liquid and gas form, contain too much carbon and too little hydrogen, compared with town's gas, the main object of the catalytic gasification of oil is to cause steam to react at high temperature with some of the excess carbon to produce hydrogen and carbon monoxide. The remainder of the excess carbon is burned to provide the necessary heat. Our line drawing shows a diagrammatic arrangement of the " Segas " oil gas plant, which operates on a regenerative cycle and consists essentially of three steel cylindrical vessels lined with refractory brick. The steam preheater and the catalyst chamber are each 8ft 6in in diameter and 16ft 6in high, and the air preheater has a diameter of 7ft 9in and a height of 21ft 6in.

To start up the plant from cold, some initial heat is required, but once in operation the necessary heat is maintained by the cycle of operations. After the initial warming up, the valve at the top of the stack is shut and steam at a pressure of 100 lb per square inch is admitted at the base of the steam preheater and is raised to a high temperature as it passes upwards through the heated brickwork, which is arranged in a honeycomb or chequer pattern. At the top of the preheater the steam meets an oil spray, the oil being at a temperature of 100 deg. Cent. and the mixture of steam and oil is ducted to the top of the catalyst chamber, where it meets a second oil spray before passing downwards through the catalyst vessel. At each oil spray the flow is in three parts, first oil only, then a mixture of oil and steam at 40 lb per square inch pressure and, finally, steam only, to ensure that the nozzles are free of oil.

In the catalyst chamber the catalyst, which is a magnesite lime, is arranged in four layers consisting of preformed hollow rings of 2½in outside diameter by 2½in thick and 1½in outside diameter by 1½in thick arranged alternatively. In passing through the catalyst the desired reaction takes place at about 1000 deg. Cent. and gas, tar vapour and carbon black are formed. The vapours pass to the bottom of the air preheater, which has brickwork arranged in the same manner as in the steam preheater, and as the vapours rise through the comparatively cool brickwork of the preheater there is an interchange of heat, the brickwork is raised in temperature and the hot gas is cooled. The cooled vapours pass from the top of the air preheater downwards to the wash-box, where the tar is removed, and then flow to the base of a Lymn washer, where the gas is cooled and washed in a water spray. From here the gas is piped to Livesey washers and then to meters.

When this part of the cycle is completed, the time taken being about three minutes, there is a reversal of the cycle. The gas offtake valve, the oil fuel valves and the process steam valve are closed and the stack outlet valve opened, then air at a pressure of 30in w.g. is admitted through a control valve at the top of the air preheater. The air flows downwards through the preheater and cools the heated brickwork, while raising its own temperature, and then flows upwards through the catalyst chamber burning the carbon from the catalyst. This action raises the temperature of the catalyst to its working temperature and the hot air passes downwards through the steam preheater to raise the temperature of the brickwork before passing out through the stack. Immediately following this period of air regeneration a short burst of purge steam, at about 55 lb per square inch pressure, is admitted at the top of the air preheater to pass backwards through the plant to clear the system of air and to ensure that no explosive mixture is formed.

All the valves are automatically closed and opened in their correct sequence and the process takes six minutes to complete so that there are ten cycles per hour. The plant uses 130 gallons of oil having a viscosity of 200 seconds Redwood I per hour and the amount of steam and air used is 2600 lb and 9500 lb per hour respectively, while from 1 gallon of oil 1·15 therms of gas having a calorific value of between 480 to 508 B.Th.U. per cubic foot are made.



Diagrammatic Arrangement of the "Segas" Process

THE ENGINEER

Vol. 197 JANUARY 1, 1954 No. 5110

LEADING ARTICLE—
Retrospect ... 20

ARTICLES—
Aeronautics in 1953. No. I. (Illus.) ... 16
Atomic Energy in 1953. (Illus.) ... 5
British Iron and Steel Federation ... 1
British Iron and Steel Industry in 1953. No. I (Illus.) ... 27
British-built Locomotives in 1953. (Illus.) ... 33
Civil Engineering in 1953. No. I. (Illus.) ... 2
Electrical Engineering in 1953. No. I. (Illus.) 24
Enterprise in Shipbuilding ... 1
Gas from Oil Plant. (Illus.) ... 19
Labour in 1953. No. I ... 11
Locomotive Builder's Jubilee ... 1
Milling Machine. (Illus.) ... 36
Mr. J. E. Hodgkin ... 1
Mr. W. E. Benbow ... 1
National Research Development Corporation 1
Naval Construction in 1953. No. I. (Illus.)... 29
Quick Action Fastener. (Illus.) ... 36
Railway Coach Construction. (Illus.) ... 36
Royal Navy, 1953. No. I. (Illus.) ... 8
Shipbuilding and Marine Engineering in 1953. No. I. (Illus.) ... 13

LETTERS TO THE EDITOR—
Locomotive Testing at Swindon ... 23

LITERATURE ... 23
Books Received ... 22

NEWS AND NOTES—
British Patent Specifications. (Illus.) ... 39
Calendars and Diaries ... 40
Catalogues ... 40
Contracts ... 38
Forthcoming Engagements ... 40
Industrial and Labour Notes ... 37
Launches and Trial Trips ... 38
Notes and Memoranda ... 38
Personal and Business ... 38

EIGHT ART PLATES—
Small Naval Craft of 1953 ; Power Stations of 1953 ; Steel Works of 1953 ; Marine Gas Turbines of 1953 ; Two Machine Tools of 1953 ; Cargo Ships of 1953 ; Locomotives of 1953 ; East Coast Sea Defence Works of 1953.

RETROSPECT

For what other reason do we survey the past than in the hope of divining, even though only vaguely, what the future may hold in store ? It is never possible to look back upon what the Americans call " a year gone " without thinking also about the year to come ; and as this New Year of 1954 opens it is even less possible than usual. For the Old Year, in which for the first time, through a remarkably successful technical achievement, television screens literally brought home to millions the spiritual significance as well as the gorgeous ceremonial of the Coronation, may well prove to have been a year of special significance in other ways as well. The war ended eight years ago. Yet not once since then, in reviewing, as a digit in the date has changed, " What's past and what's to come " has it been possible to look ahead with any confidence in prediction. Britain's economic fortunes, those fortunes that fundamentally affect our lives and actions, have had ever since the war a weathercock quality. If at Christmas the sterling area's financial reserves have been booming upwards, then, for a surety, the pessimists have soon been justified. By the following autumn a new financial crisis has been looming. And, in reverse, if the reserves at Christmastide have been dwindling towards disaster point then under a summer's sun the optimists have found cause to crow. Dependent upon the predilections of the mind the country has either been conceived as staggering from crisis to ever-worse crisis, or merely suffering from the disadvantage of a reserve of gold and dollars rather too small effectively to damp out quite normal fluctuations of the post-war trade cycle. What may be significant in 1953 is that it did not run true to this form. The economic climate steadied. Controls were relaxed, taxation was reduced, the cost-of-living index became almost stationary. But no financial crisis developed. The central reserves continued slowly to increase. Everything suggested that the country's economy and that of the sterling area as a whole was softening down to a less disturbing and exacting rhythm.

But if there were, indeed, signs in 1953 that greater economic stability was returning to the world the reason for it was not far to seek. Last year productive capacity at long last caught up on demand. In earlier years, and even so lately as 1952, measures taken by the countries of the sterling area to place that monetary unit upon a more secure footing in the world's esteem had the effects of closing certain markets to British goods and of making sterling so scarce in others that orders were lost not because prices were too high or dates of delivery too far off, but because quotas had been exceeded or because exchange was not available, or because unduly long credit was demanded. In 1953, that situation began to be relaxed. Instead, and as a direct consequence of the coming into play of new productive resources, notably in Germany and Japan, world-wide competition for orders began to become severe. British engineering firms found themselves forced seriously to consider in seeking orders whether producers elsewhere might be able to undersell them or offer in other ways more advantageous terms. Two German firms, for example, secured a contract for the erection of steelworks in India by agreeing to terms that no British manufacturer could offer. It became, in fact, markedly obvious during 1953 that if the high rate of British engineering (and other) exports was to be maintained and expanded, prices must be held down. The period had finally and at last come to an end during which it was not price that ruled how much could be sold, but only the rate at which goods could be produced. It is that change, long foreseen to be inevitable, but which really came upon the world in 1953, that makes it less possible than ever in looking back upon the past to avoid also peering forwards to where " loitering slow, the Future creepeth." For the consequences of the change may be profound ; it is more than fourteen years since similar conditions ruled in export markets ; many a younger executive has never experienced such conditions before ; and many a lesson in vigorous salesmanship may have to be relearned.

PRODUCTION AND PRODUCTIVITY

Since the war emphasis has been especially laid upon raising industrial production, and the improvement of productivity has been visualised as a means of increasing an output, about whose saleability there was little doubt, from a limited labour force. The effort has been successful. In 1953, it seems probable, the industrial output of this country, recovering from the set-back of 1952, once again reached record levels. But under the more fiercely competitive conditions now developing the demand of the world may prove to be much more nearly in balance with the world's productive resources. The improvement of productivity may therefore come to be thought upon in the future as much as a means of keeping costs down as a method of pressing output up. In one sense such a shift of emphasis might have beneficial consequences. For many a firm during the last few years has been able to sell its whole output, has been doing very nicely, and under a system of taxation that relieves it of so much profit, has had little incentive to press up output by adopting new methods. The pressure of competition may induce new thinking. Those local productivity committees which the British Productivity Council was setting up during the year in 105 towns and districts of the United Kingdom may find firms that have so far taken only a languid interest in their proceedings showing a suddenly awakened desire for new knowledge. But there is another facet of the matter. If shop stewards and men on the shop floor are to take, as it is very desirable they should take, a real interest in raising productivity it will have to be demonstrated that even under keenly competitive conditions improved productivity cannot merely reduce manufacturing costs, but reduce them substantially enough to make an increased output saleable. The Trade Unions have taken little enough interest to date in raising productivity, though many of their leaders are well aware that in the longer run it must inevitably benefit their members. But at least since the war and under conditions of full employment the resistance at shop floor level to the introduction of new methods and new machinery has been less extreme than in pre-war days. Were it to happen, however, under the stress of competition that improvement of productivity came to be seen solely as a means of reducing costs and not also as a means of raising output, what little sympathy the workpeople show towards it would be wholly lost in fears of unemployment. The Luddites merely sleep. They are not dead.

LABOUR

Even after the National Union of Railwaymen had threatened to call out its members on strike just before Christmas, it was widely admitted, despite the resentment aroused, that railwaymen were underpaid in relation to other workers. Thus, though the British Transport Commission had argued throughout lengthy preceding negotiations that neither industry nor the public would tolerate higher fares and freight rates, in fact

the agreement finally reached was welcomed. With exemplary speed the Commission and the three unions concerned began new negotiations before Christmas upon a more substantial increase in wage rates than that awarded by the Railway Staff National Tribunal and about the modification of the whole railway wages structure. Industry and the public have still to learn what the cost will be.

But a similar argument cannot be applied to rates of wages in engineering works and shipyards. For earnings in those industries are already high. Nevertheless, following upon increases received in each of the two preceding years and despite the fact that little, if any, justification could be found in a change of the cost of living the Confederation of Shipbuilding and Engineering Unions during 1953 put in a claim for a 15 per cent weekly increase. The claim was strongly resisted by the employers. For both industries are open to international competition and though both have heavy order books neither is happy about the manner in which new orders are coming in. Figures of orders for new ships are particularly disturbing and it seems obvious that costs are already too high relative to those of Continental competitors. In both industries it is clearly imperative that costs should be kept down if export trade is to be maintained. But engineering and shipbuilding employers can now no longer look towards the early months of the present year with equanimity. Late in 1953 the Confederation called out its men for a twenty-four-hour strike. It was a foolish business for it proved nothing and effected nothing. But unless there is an unexpected change of mood amongst the men's leaders, more particularly those of the A.E.U., the largest union in the Confederation, there is a probability that more serious strike action will take place. For the men seemed to be convinced that the cost of increased wages could be met from supposedly inordinate profits and need not be passed on to consumers. As the year drew to a close the Confederation decided to call upon its members for a ban upon overtime and a limitation upon piecework. If effect is given to that threatened action, the output of the engineering industries will be greatly reduced and there will be serious consequences for Britain's economy. No doubt it is for that reason that the Minister of Labour has intervened, in an endeavour to bring the two sides together.

Research and Development

Ever since the war Governmental and other spokesmen have been very fond of stressing the importance to this industrial and exporting country of research and development so that its products should hold their places in export markets through advanced design. But annually the work of the D.S.I.R. and of the various industrial research organisations which receive grants from that department has been hampered by the fact that there was no certainty as between one year and the next what scale of expenditure the Government would permit. In 1953 enlightened action appears to have followed upon a realisation that a stupid one had been committed. Rather more than two years ago the Government, as one of the less wise economies it was making under the stress of the financial crisis, decided to reduce the financial aid made available to the department. It was promptly subjected to firm criticism not only in the press but by the Advisory Council for Scientific and Industrial Research. Last month—repentance, even if belated, is still welcome—it restored the cuts. It did more. Perhaps in penance for its past offence, it agreed that grants should no longer be made annually but that expenditure should be laid down over a term of five years, thus permitting research work to be more securely planned ahead. Welcome, too, was the apparently firm decision to spend within the next five years £6,000,000 upon research buildings. Amongst them are new buildings of the Mechanical Engineering Research Laboratory at East Kilbride, where urgently needed research has been sadly delayed for lack of them, a new home for the Road Research Laboratory, and the projected new ship tank at the National Physical Laboratory.

Education

During the two terms of the late Labour Government there was a ferment amongst educationists aroused largely by the realisation that much expanded capacity for technological education must be provided if industry was to receive a sufficient number of trained men. All the excitement led to that Government's heavily criticised proposal to set up a Royal College of Technologists and to expand the work of technical colleges in general. That proved to be a proposal that the Conservative administration promptly dropped. Nor has much been done to replace it. Early in the past year the Government did, indeed, announce that it was the intention to increase the number of students at the Imperial College of Science and Technology to 3000, almost twice as many as at present, and to aim at doing so around the present sites of the College. But though there seemed to be an impression that it was the intention to choose and adopt a small number of other colleges elsewhere in the country to act as technological colleges nothing else was done during the year.

In the meanwhile, however, education itself came under attack. It began to be appreciated that the opportunity to reach a university education had been opened so widely that it was not only possible for any talented youngster from any stratum of society to have a university education but that it was becoming positively difficult for him to avoid such instruction. The question began to be asked whether such a provision was wise. In his Presidential Address to the Institution of Mechanical Engineers three years ago Sir David Pye set off discussion upon the virtues or defects of a university training for designers, a discussion within which during last year Professor M'Ewen, of Durham University, made some very pertinent comments in this journal. Designers ought to benefit from a university course. But do they ? The evidence seems to be against it. Again, last October, another President of the same institution implicitly cast reflections upon a system that so strongly favours university training. Mr. Roebuck stressed the importance of craftsmanship. He could not possibly agree that the more intelligent boys having been taken away to become graduates and technicians the more stupid ones could be left to maintain craft skills. Sir Richard Southwell, too, joined the discussion, remarking in his Trueman Wood Lecture to the Royal Society of Arts that " craftsmanship calls for very high intelligence ; but not for intelligence of the sort which it is, or should be, an aim of universities to foster." Perhaps in this context, too, mention should be included of a meeting of the " Mechanicals " late in the year to discuss the practical training of university engineering students, a meeting at which the virtue of ensuring that a student spent a year in industry before entering a university was stressed. It will be interesting to see where all this renewed interest in the more practical aspects of engineering, as opposed to the academic, leads in this present year of 1954.

Disasters

The history of engineering has repeatedly shown that those who have lost their lives in disasters never die wholly in vain. Lessons are invariably learnt that make the occurrence of a similar disaster very unlikely. Never again, for example, will a ship be sent to sea designed, built and operated with quite the same weaknesses that the inquiry into the loss of the cross-channel vessel "Princess Victoria" on the morning of January 31, 1953, revealed. She sank during the course of an ordinary routine passage from Stranraer to Larne under stormy, but by no means unprecedentedly stormy conditions. She sank, according to the conclusions of a court of inquiry, because the strength of her stern doors was inadequate and because the capacity of the scuppers to clear her car deck rapidly of any large quantity of water was also inadequate. In retrospect disasters are often seen to be inevitable sooner or later. Those who could, by taking strong action, have prevented them, seem blinded by the gods to the danger, despite black auguries. So it was with the " Princess Victoria." Previous events had revealed her weaknesses. The significance of those events passed unappreciated by those who could have had her defects rectified.

It was another consequence of that storm at the end of January, in which the " Princess Victoria " was overhelmed by the seas, that a " surge " occurred in the North Sea nearly coincident with high tide. Sea defences along England's eastern and south-eastern coasts, and even more overwhelmingly around the Dutch islands and mainland in the estuaries of the Meuse and Rhine, were overtopped. Damage and loss of life (there were nearly 300 deaths) were heavy enough in this country. But they did not approach in scale those experienced in Holland. Again lessons are being learned. The new sea defences constructed during the year—some of which are illustrated in Plate 8 of this issue—will provide more effective protection than those they replace. It would, of course, be possible, but not everywhere easily practicable to build up those defences to such a height that no surge of the North Sea, however closely coincident with high tide, could overtop them. But it is probably uneconomic to do so. What can be done at

more reasonable expense is to ensure that, once overtopped, the defences are not breached. Repeatedly when the damage done by the floods came to be surveyed it was revealed that it was the back, the landward side, that had proved vulnerable. Slip of the back face, the commonest cause of failure; permitted the formation of a breach, and the breach once formed was widened by the inward—and later the outward—rush of water. Had those breaches not formed as the defences were overtopped, the flooding that took place would have been far less severe, far less widespread, and much easier to cope with after the tide had turned. That flooding of the East Coast, following so closely upon the previous year's disaster at Lynmouth, led to an unusual show of interest in floods in general. It emerged that floods of disastrous magnitude as measured by loss of life and damage done, are much more frequent in these islands than is commonly appreciated, and our contemporary *Nature* suggested that a *prima facie* case exists for a committee of inquiry to investigate the matter.

In 1953, too, it became more and more generally recognised—it was fully realised by a few at the time—that the thick, widespread and filthy " smog " that enshrouded London between December 5 and 8, 1952, had produced a disaster of great magnitude and been responsible more or less directly for the deaths of some 4000 people. Measurements made during the smog period revealed that concentrations of smoke and sulphur dioxide far below levels accepted as toxic for long exposure had yet proved lethal. Growing appreciation of the immensity of the disaster led to a concentration of interest upon measures for preventing air pollution, and in July the Government set up a committee under the chairmanship of Sir Hugh Beaver to investigate the matter. Late in the year that committee issued an interim report. It cannot be said to have thrown much new light upon the matter. For its object was rather to delineate the problem than to provide solutions. At least it made clear how very much more has to be learned about " smog " and the various sources that contribute to its toxic qualities before effective remedial action can be taken. It has, for example, never been satisfactorily determined whether the washing of power station flue gases is really desirable or not. For the discharge of the warmer unwashed gases from high chimneys may be just as effective in preventing the formation of high concentrations of sulphur dioxide at ground level as is washing. Far better dispersal is probably effected.

The repercussions of a yet earlier disaster, that upon the railways at Harrow, were still being felt in 1953 as experiments were made with systems of automatic train control. But the Government did little to mitigate the disaster which occurs every year upon the roads of this country and which is far greater in magnitude than any of those discussed. Last year some 5000 people lost their lives in road accidents and some 200,000 were injured. If only to ease this holocaust heavy expenditure, far heavier than that increased amount promised by the Government for 1954, would be justified. But just as high an expenditure is justified on the purely economic grounds that transport costs would be lowered by improvement of the roads.

Nationalisation and De-Nationalisation

Two de-nationalisation measures became effective in 1953, those affecting the iron and steel industry and long-distance road haulage. The sale of assets back to private enterprise was begun. But certain provisions of the Iron and Steel Bill as first presented to Parliament proved deeply disturbing to iron founders and particularly to owners of tied foundries within the engineering industry. Fortunately, the Government proved amenable to reason and most of the offending clauses were amended. The situation perpetuated when the Bill became an Act is that all foundries, tied or untied, are required to provide the Iron and Steel Board, which has oversight over the whole industry, with certain statistical information. As, however, it is information that all firms presumably collect for their own purposes that provision is not specially onerous. In return, the foundries are represented on the Board by a part-time member so that their interests in obtaining, for example, ample supplies of raw materials, are protected at the highest level. Objection even to those mild provisions was still taken by many firms. It appeared to be founded upon a fear that if and when a Labour Government again came into power, it would once more nationalise the iron and steel industry and, finding an excuse in the Conservative measure, extend public ownership much more widely than before. But that fear seemed irrational upon two counts. First, the Conservative measure appeared from the start to be a sincere attempt to synthesise moderate opinion. While restoring the industry to private enterprise in consonance with Conservative desires, it was still designed to provide that really adequate supervision of the industry that socialists feel is essential. Despite conventional socialist thundering against the Bill in the House it now seems rather unlikely that any but the extremer element will want to interfere again, at least until the new organisation has had a fair trial. Secondly, belief in the virtues of nationalisation as a sole effective means of exercising public control over basic industries is fading under the light of experience. It was, indeed, noticeable during the year that discussions of nationalised industries were becoming more detailed and less partisan. Perhaps the fact that Conservative Ministers have to answer for those industries in the House had something to do with the change. For Labour Ministers, when in power, felt bound to come to their defence when attacked. But Conservative Ministers, though as much aware of their responsibilities towards them, have felt no such compulsion and have thus been able to support discussions with more detachment and less heat. Moreover, it became increasingly obvious during the year that the creation of nationalised industries has not achieved all that was hoped. The National Coal Board, which is failing to get in augmented output an adequate return for its capital expenditure, found it necessary during the year to set up an inquiry into the efficiency of its own organisation. Soon it may find itself strongly resisting a wage claim. The organisation of transport under its Commission and Executives was generally admitted to be top-heavy even before the Transport Act, 1953, de-nationalised its road section and called for decentralisation of the railways. The British Electricity Authority, the Gas Boards and the National Coal Board have not proved capable of devising or even seriously discussing any form of national fuel and power policy; and the fact that a strike threat had to be used before railwaymen could get what they believed to be a fully justifiable increase in wages illustrates that nationalisation cannot alter that fundamental relationship between employers and employed which arises from their necessarily differing ways of thinking about economic matters. Moreover, how, effectively, to make nationalised industries answerable to Parliament, whilst still leaving them independent of politics, began to be seen to be a really difficult, if not an insoluble, problem. In the circumstances, socialist enthusiasm for nationalisation as a policy to be further extended was waning. Even should a Labour Government be returned to power at the next election it seems improbable that engineering firms with tied foundries need fear the outcome.

" The Glories of the Possible are Ours "

Unquestionably the Coronation was the central event of 1953. Through television and the cinema it carried to all the world a message about the unity, purpose and confidence of the Commonwealth of Nations and the Realms and Territories of which the Queen is the Head. Its heartening and unifying effect was far from spent as the year ended. May memory of it act as an inspiration for many years to come. Pope was right to exclaim, " Oh blindness to the future ! kindly given." Because we cannot know what lies in store we can the more easily contemplate at the joyous opening of a new reign, not the terrible disasters that may befall mankind in this age of atomic warfare, but the long course of beneficial achievement that could lie ahead and the enormous opportunities that still exist in the world for engineers to benefit mankind. In this issue there are reviewed the technical advances made by engineers in a single year. How very much greater will those advances have become before what everyone hopes will be the long reign of Queen Elizabeth II ends ! For no men more truthfully than engineers can exclaim, " The Glories of the Possible are ours ! " And as techniques improve and knowledge widens, the bounds of possibility expand. Heaven grant the Queen a reign so peaceful that men looking back upon the achievements and the prosperity of the latter half of this, the twentieth, century will hail it as a golden age.

Books Received

Colliery Year Book and Coal Trades Directory, 1953. Thirty-first edition. Published in London by The Louis Cassier Company, Ltd., Dorset House, Stamford Street, S.E.1. Price 30s.

Copper In Instrumentation. Issued by the Copper Development Association, Kendals Hall, Radlett, Herts. Copies of the book are obtainable free of charge on application to the Association.

An Introduction to the Theory and Application of Motion Study. By Anne G. Shaw. Manchester : Harlequin Press Company, Ltd., Old Colony House, South King Street, Manchester, 2. Price 6s.

Literature

Vermuyden and the Fens. By L. E. HARRIS. London: Cleaver-Hume Press Ltd., 42A, South Audley Street, W.1. Price 21s.

THIS book is a biography of Cornelius Vermuyden and is written to vindicate his genius, for he was consistently and virulently abused from the time he flourished (1621–1655 in England) till the end of the nineteenth century. Interest in Vermuyden then languished till the last few years, when the South Level of the Fens, having suffered from a succession of floods culminating in the disaster of 1947, again came into the public eye, with an accompanying glorification of the achievements and plans of Vermuyden 300 years ago.

For some years before the Twelve-Year Truce between the Netherlands and Spain due to end in 1621, Dutchmen had been active in England promoting schemes to reclaim land, as they could not hope to continue such work in the Netherlands after the end of the truce. Among the leading Dutchmen who came to England for this purpose was Joachim Liens, who was a brother-in-law of Cornelius Vermuyden. The chief prize for the land speculators was the Great Level, the Fens, but despite all proposals and although Joachim Liens was knighted in 1619 for services unspecified, nevertheless in 1621 the King decided to "go it alone" as regards fen reclamation. He, however, did nothing and Charles granted no concession for fens reclamation till 1630.

Sir Joachim Liens had fetched his brother-in-law, Vermuyden, over in 1621. The latter was at that time thirty-one years old and already chief representative of the Government (Head Bailiff) in his town, St. Martensdijk, and district; he came of a sound upper middle-class family, settled in that town for several centuries. No doubt Sir Joachim knew him for a capable and energetic administrator, and did not bother about his character, which is described by his biographer as being tactless, overbearing, ruthless, unscrupulous, doubtfully honest and disloyal. There is no indication that he had any professional and practical experience of land drainage or reclamation, prior to coming to England.

The Commissioners of Sewers were induced to give Vermuyden the closing of a breach in the Thames bank at Dagenham, and had to report in 1623 that "the land was in worse condition than it was before." It appears that his estimate was £2000, but the final cost £3600, and no doubt he skimped the work to reduce his overspending. However, King James stood by him and gave him a small job of draining Windsor Park, and later King Charles gave him some land at Dagenham. His next job was to reclaim (with Dutch finance) 70,000 acres of swamp on the Royal Chase of Hatfield, near Doncaster, which was again a complete failure. But the excuses given in the book leave the reader confused. The author says the plan was sound in theory, though it caused the financial failure of the scheme; but, he continues, it is not fair to say it was technically a failure though experience showed that certain features might have been treated differently. There is no record of Vermuyden's proposals and no plan, but there was rioting and destruction of his works; Vermuyden's Dutch workmen killed one of the peasants. We then have the following sequence of events: in July, 1628, Vermuyden bought some of the King's Manors in the Royal Chase for £10,000; in October, 1628, a troop of fifty horse quieted the peasants with "threats of fire and vengeance" and stopped the sabotage; in January, 1629, Vermuyden was knighted. Nevertheless, troubles continued, till in 1633 the promoters had to cut the Dutch River at a cost of £20,000 to take the drainage of the Royal Chase into the Yorkshire Ouse. This ruined Vermuyden's partners. But it did not ruin Vermuyden (though he was imprisoned for a time).

Vermuyden's last work was the draining of the Fens in two stages from 1630 to 1637 and 1650 to 1653. The book gives a full account of the financial and administrative intrigues, scandals and quarrels, induced by a possible prize of £60,000 per annum from a capital expenditure of £100,000. The first state was the digging of the Bedford River, 21 miles long and 70ft wide, which was completed in 1637. The Commission of Sewers then declared the work satisfactorily done, but in 1638, the Commission, whether the same or another is not clear, declared the work incomplete and refused the agreed grant of land. The project and plans of Vermuyden for this part of the scheme have not survived, but the author thinks that while the concession of 1630 called for both winter and summer drainage, the Bedford River provided summer drainage only.

In May, 1649, Parliament passed the "Pretended Act," which gave the Fen Reclamation Concession to the then Earl of Bedford. By January, 1650, the concessionaires had managed to get agreement with Vermuyden on the terms of his employment as director of works. Two months later the concessionaires obtained an "adjudication" that the first part of the work was done (which meant, of course, that the Commission of Sewers now recognised the work done from 1630 to 1637) and awarded about 58,000 acres to the concessionaires as payment. The whole work was finished by March, 1653, when the Commission handed over a further 37,000 acres. The additional work done in this period was to cut the New Bedford River (the 100ft River) parallel to the original Bedford River, to help to drain the water from the North Level (part of the Great Level) into the Ouse below Denver. What Vermuyden did from 1653 till February, 1655, when he resigned from, or was sacked by, the concessionaires is not known.

To drain a swamp by cutting a channel to the nearest river or depression lying at a lower level is easy and effective, but conscienceless, for such action drains the land at the top end of the channel and floods the lower end. Vermuyden did this in draining the Royal Chase, but it apparently taught him nothing. He prepared for King Charles a "Discourse touching the Draining of the Great Fennes" in 1638, published in 1652, but only brief references are given in the book, stating that the 1649 project included a cut-off channel to intercept the rivers flowing into the South Level (part of the Great Level) and a relief channel, parallel to the Ouse from Denver, to carry away the water previously forming the Swamps. A diagram in the book shows Vermuyden's scheme, as including a cut-off channel discharging into the Ouse, but no relief channel. Such a cut-off channel by itself would be of little value to the South Level and would spoil the drainage of the North and Middle Levels, but it was not made, nor was a relief channel even if then projected. The Bedford River and the 100ft River were beneficial to the latter two levels, but left the South Level in a more perilous state than before, as was recognised very soon after 1653, and ever since, by many engineers, including Sir John Rennie in 1839.

Vermuyden had repeated the blunders he made at the Royal Chase, but actually he should not be blamed for the bad effect of the Bedford Rivers on the South Level because they were not his idea, but that of Sir Robert Sevill's Commission in 1605. The author states this quite definitely, but nevertheless calls Vermuyden the master-mind that evolved the plan.

Vermuyden is not to be blamed for knowing nothing about hydrology; for no one did at that time. He can, however, on the evidence of this book, hardly be acclaimed as a genius, or a great engineer, for he appears only as a forceful and unscrupulous contractor, who did not learn from experience, but carried out an old and imperfect scheme prepared by others, while neither he nor the people who employed him cared a fig as to what happened to anyone else. "*Apres moi le deluge*" was their motto and the South Level has suffered the consequences of their work for three centuries.

The whole story as told by the author provides an insight into the conditions under which a contractor worked in a period when few men seem to have been either scrupulous or incorruptible. The book is not without technical interest, but the human and the historical aspects predominate.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

LOCOMOTIVE TESTING AT SWINDON

SIR,—I would like to pay tribute to your scrupulous fairness in publishing in the issue of December 12th the hail of well-deserved criticism aimed at your recent editorial on the above subject. That ever-faithful defender of "Nationalised Honour," Mr. O. S. Nock, too, deserves due credit for acknowledging so promptly the debt which controlled road testing owes to the late Great Western Railway.

Speaking of running at constant evaporation, in his letter of December 12th, Mr. Nock observes that: "No one in his senses would think of running the whole way from Derby to Manchester under such conditions." Too true! But both Mr. Ell's paper and your editorial comment led us to believe that, because locomotives can now be tested under these conditions, the results can immediately be used to fix accurate time-tables for every kind of route. The selection of so extreme an example serves only to underline the absurdity of such a deduction.

I quite agree with Mr. Nock that a schedule time of 10 min is much too short for the 4·6 miles from Millers Dale to Peak Forest with a load of eleven coaches (one more, I believe, than the normal roster for even a "Jubilee" class locomotive, the largest in regular use on this line), at least with nationalised standards of locomotive maintenance and with nationalised coal. Intelligent observation, rather than Ellian researches, would have enabled British Railways to correct this error in timing, had they the wit to employ it.

Out of a considerable number of pre-war runs, with which comparison will no doubt be denounced as horribly unfair, the shortest time that I have, personally, recorded for one of these engines is 8 min 15 sec over this stretch, with an eight-coach train. Even a Midland compound has been observed to take nine cars up in 9 min 39 sec, so that it should be no unreasonable attainment for a "Jubilee" to do the run in 10 min with ten coaches under similar conditions.

Sooner or later British Railways supporters will perhaps learn the lesson that criticism, however inconvenient, cannot necessarily be dismissed as irresponsible or as being made without knowledge.

"PYROTECHNIC"

December 22, 1953.

Electrical Engineering in 1953

No. I

SINCE the war the sales of electricity in Britain have been increasing by something like 10 per cent annually, except in 1952, when, as a result of the partial recession in trade, the rate of increase fell sharply. In November, 1952, for example, the annual rate of increase averaged over the country as a whole was only 2·6 per cent, compared with 9·8 per cent in November, 1951. By the end of 1952, however, there were signs of an upward trend, and this improvement was maintained in 1953 : the rate rose to 7·9 per cent in October and 8 per cent in November. All the figures quoted have been corrected to allow for differences in the weather and other variables, so that the comparisons are on an equitable basis.

To meet the growing demand that these figures imply, the British Electricity Authority has been responsible for the commissioning of new power stations and extensions to existing power stations on a scale which has reached very substantial dimensions in the past two years. It will be recalled that the total capacity of new generating plant installed in 1951 was 1113MW and in 1952 was 1539MW. The comparable figure for last year is not available at the time of going to press, but the new plant commissioned up to that time totalled 1368MW of generating plant and 15,300 k-lb per hour of boiler plant. Details of this plant are given in the accompanying table, which includes a number of new power stations in which plant was commissioned for the first time. Brief descriptions of five of these new stations are given later in this article.

TABLE—*New Generating Plant Commissioned During* 1953*

Station	Division	Turbo-alternators		Boilers	
		No.	MW(I)	No.	k-lb per hour
Bankside	London	1	60	2	375
Barking "C"	London	1	75	2	405
Battersea "B"	London	1	100	1	425
Bold	Merseyside and North Wales	1	30	1	300
Brachead	S.W. Scotland	1	50	1	300
Brighton "B"	S. Eastern	2	52·5	2	320
Bromborough	Merseyside and North Wales	—	—	2	300
Brunswick Wharf	London	1	52·5	2	320
Carmarthen Bay	S. Wales	2	52·5	4	240
Carrington	N. Western	1	60	2	360
Chadderton	N. Western	1	60	1	360
Clarence Dock	Merseyside and North Wales	1	51·5	—	—
Connah's Quay	Merseyside and North Wales	1	30	1	300
Croydon "B"	S. Eastern	—	—	1	320
Deptford East	London	1	52·5	2	250
Doncaster	Yorkshire	1	30	3	180
East Yelland	S. Western	2	30	4	180
Huddersfield	Yorkshire	1	30	1	180
Huncoat	N. Western	—	—	1	305
Keadby	Yorkshire	1	60	1	550
Littlebrook "C"	S. Eastern	2	60	2	360
Nechells "B"	Midlands	1	52·5	4	230
North Tees "C"	N. Eastern	1	60	3	360
Poole	Southern	—	—	2	300
Roosecote	N. Western	2	30	2	300
Rotherham	Yorkshire	—	—	1	200
Rye House	Eastern	2	32	2	350
Skelton Grange	Yorkshire	—	—	1	360
Staythorpe	E. Midlands	—	—	2	240
Thornhill	Yorkshire	—	—	2	200
Uskmouth	S. Wales	1	60	3	360
Walsall	Midlands	—	—	3	180
West Ham	London	—	—	1	180
Westwood	N. Western	1	30	1	300
	Totals	30	1368	63	15,300

* At the time of going to Press.

Although the amount of new plant installed represents a substantial achievement, it is not viewed by the B.E.A. with any complacency. On the contrary, the Authority has repeatedly resisted any suggestions that future plant programmes should be curtailed. The shortage of generating plant remains serious, despite the fact that the deficiency has been reduced in recent years. According to the B.E.A. report for 1952–53, the estimated shortage of generating capacity at the item of maximum potential demand (December 15, 1952) was 1549MW (sent out) and would have been no less than 2400MW if the weather had been extremely cold and if no load spreading arrangements had been in force. It is clear, therefore, that, although there may be less chance of load shedding this winter, the risk is one which depends very much on the weather and that the need for increased generating capacity and, incidentally, transmission facilities is still urgent.

The serious effects of generating plant shortage have been tempered by co-ordinating the programme for carrying out plant overhaul. During the peak load winter months December to February, overhaul is now limited to urgent repairs. In March, April, October and November, when unexpectedly severe weather can cause critically heavy loading on the public supply system, the average loss of capacity because of overhaul was reduced in 1952 to 63 per cent of the corresponding figure for 1950. This improvement is equivalent to the provision of an extra 600MW of generating plant in the months concerned.

Carmarthen Bay Power Station

During the year two 52·5MW generating sets and four 240,000 lb per hour boilers were commissioned in Carmarthen Bay power station which, when completed, will have an installed capacity of 345MW. The station was planned prior to vesting date and is sited at Burry Port on the Burry Estuary, Carmarthenshire. Sea-water from the estuary is used for the condensers and, because there is a tidal range of about 33ft, the pump-house on the foreshore had to be at a considerable depth to ensure that the suction side of the pumps would be flooded at low tide.

There are storage facilities for 140,000 tons of coal, mainly from Glamorganshire coal-fields. Steam is generated at 950 lb per square inch, 925 deg. Fah., in Babcock and Wilcox 240,000 lb per hour p.f. boilers, of which there will be eighteen in the completed station. Each generating set takes steam from a receiver fed by three boilers. The first two sets are rated at 52·5MW and are air cooled. The next four sets will have hydrogen cooled alternators of 60MW rating. All the turbo-alternators are Metropolitan-Vickers sets with three-cylinder turbines.

There are six ASEA water cooled generator transformers—two of 63MVA and four of 72MVA—to step up the generator output from 11·8kV to 132kV, and they are installed indoors alongside the turbine-house. The main 132kV switchgear is 2500MVA air-blast, outdoor equipment by Ferguson Pailin, Ltd.

A general view of the station is reproduced in Plate 2, between pages 12 and 13. The consultant and contractor for the whole station, with the exception of the 132kV switchgear connecting the station to the grid, is Balfour Beatty and Co., Ltd., and the consulting architect is Sir Percy Thomas.

Doncaster Power Station

Doncaster power station (illustrated in Plate 2) is built on an island site bounded on two sides by the rivers Don and Cheswold, and on the third side by the Sheffield and South Yorkshire Canal. We may note, in passing, that the project for this new power station provided an opportunity for carrying out flood prevention work in association with the Yorkshire Ouse River Board, who arranged with the British Electricity Authority for the construction of a new cut, straightening out a bend in the Don, with a controlled weir and sluice gates. A new weir was also built across the Cheswold to enable the river level to be controlled for circulating water requirements. Circulating water will be taken from the Cheswold and discharged to the Don, but provision is being made for cooling towers to be built later, if required.

The only facilities for coaling to the bunkers will be by barge or road and ash disposal will be effected by a submerged ash belt feeding an external ash bunker for loading lorries.

When complete the station will have an installed capacity of 120MW, consisting of four 30MW generating sets and eight 180,000 lb per hour boilers. These boilers, two of which were commissioned during the year, are chain-grate, stoker-fired units operating at 650 lb per square inch and 800 deg. Fah., made by the Mitchell Engineering Company, Ltd., who also supplied the coal-handling plant.

The contracts for the turbo-alternators are shared by The General Electric Company, Ltd., and the Brush Electrical Engineering Company, Ltd. Electricity is generated at 11·8kV and stepped up by G.E.C. transformers to 66kV for grid transmission. The main switchgear is supplied by A. Reyrolle and Co., Ltd.

Interconnection at 132kV will be provided between the Doncaster switching site and the West Melton switching station. Power from the new generating station will be supplied to the existing Doncaster (Old) station and thus to the town network.

In the station building (Plate 2) extensive use is made of Georgian glass and aluminium mansard sheeting, to cover the whole of the boiler-house and the sides of the turbine-house, with the exception of the transformer and switch bays. For the roofing aluminium decking was laid on the building framework, covered with ½in insulation board and two layers of bitumen roofing, the whole being bitumen bonded and the exposed surface covered with limestone chippings. This construction proved to be economical, light and capable of speedy erection, besides

giving cover for plant erection during the structural work.

The contractor for the main civil engineering work is Higgs and Hill, Ltd., and for the superstructure J. Gerrard and Sons, Ltd. The main consultants are Ewbank and Partners, Ltd., and the civil engineering consultant is Sir William Halcrow.

Carrington Power Station

Carrington power station, which ultimately will have a generating capacity of 480MW, is being built on a site lying between the River Mersey on the north and the Manchester Ship Canal on the west. Although this site was first acquired in 1916, as an alternative to that of the Barton generating station, it was not developed until late in 1947, when work was started on the present scheme which was planned by the Manchester Corporation Electricity Department. Because of the variable quality and uncertain bearing capacity of the ground all the main works are supported on concrete cast-in-situ piles.

Coal supplies are mainly railborne, the wagons being received in the main sidings to the south-east of the station, across the Manchester road, and hauled into the coal store sidings by two diesel-driven station locomotives. The coal store is floored with 6in reinforced concrete slabs and has a capacity of 206,000 tons when stacked to a depth of 15ft. The wagons are unloaded by two side-discharging tipplers and the coal is distributed over the storage space by bulldozers. Coal can be reclaimed either into wagons on the east side of the store by two discharge ramps or on to the main tippler conveyor belting on the west side by a hopper. After weighing in the main tippler-house the coal is taken by conveyor belting through crushing and screening plant and then to the station bunkers, of which there are sixteen.

The station is divided into quarters, corresponding to the four stages of the programme of development. The building itself is of orthodox steel frame and brick panel design, all the steelwork being riveted. A 1in thick layer of cork, to provide thermal insulation, will cover the turbine-house roof.

Each quarter of the station is designed to house four boilers and two turbo-alternators. The boilers are each capable of generating 360,000 lb per hour of steam at 900 lb per square inch and 920 deg. Fah. when burning 20 tons of pulverised coal per hour at maximum continuous rating. The contractors for the boiler plant are Babcock and Wilcox, Ltd., and John Brown and Co., Ltd. The turbo-alternators are 3000 r.p.m. hydrogen cooled sets of 60MW nominal capacity made by Metropolitan-Vickers Electrical Company, Ltd., which is also supplying the condensers, feed-heating and central evaporating plant.

Circulating water is taken from the Manchester Ship Canal at the c.w. intake pump-house to the south-east of the station and, after being screened, is pumped up a 78in diameter steel pipeline, supported on piles, to the station. From the condensers the water passes through two 8ft 3in by 6ft 6in r.c. ducts over a side-discharge weir into the ship canal. To avoid heating the intake water the outfall is sited about half a mile below the intake.

The civil engineering consultant is C. S. Allott and Sons (Ltd.), and the main civil engineering contractor is A. Monk and Co., Ltd., while W. J. and R. Watson, Ltd., is responsible for the superstructure and Sir Wm. Arrol and Co. for the structural steelwork.

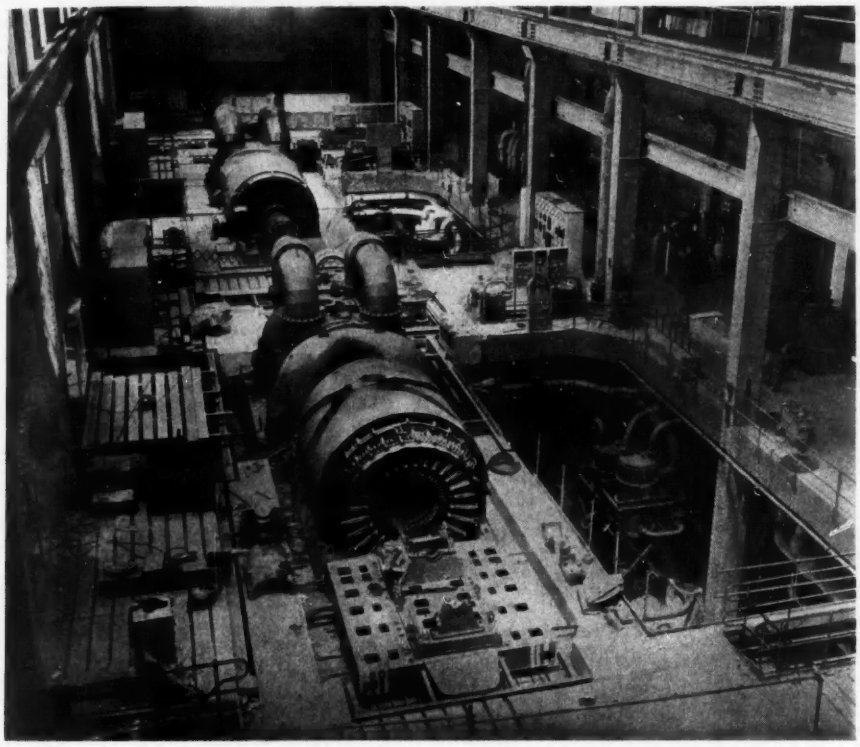


Fig. 1—30MW Turbo-Alternators During Erection in East Yelland Power Station

East Yelland Power Station

East Yelland power station is a new power station which is being built on the south bank of the Taw estuary, about halfway between Barnstaple and Bideford. Access is obtained by a road about half a mile long from the main A39 road, via a level crossing over the main line from Barnstaple to Bideford, which borders the site on the south. Cooling water will be taken from the River Taw by two 6ft diameter tunnels running from the intake to the pump-house; the outfall is situated on the west side of the station. Coal supplies will be seaborne and a 530ft long jetty has been built in the River Taw. After being unloaded by two jetty cranes the coal will be taken by conveyor belts to the coal store and station bunkers.

The station is planned for an ultimate generating capacity of 180MW, to be provided by six 30MW turbo-alternators and eleven 180,000 lb per hour boilers with turbine stop-valve steam conditions of 600 lb per square inch and 850 deg. Fah. As shown in the table, two of the generating sets and four boilers were commissioned in 1953.

The boilers are made by the John Thompson Water Tube Boiler Company, Ltd. They are of the company's two drum design with an additional steam receiver drum and a continuous loop superheater and interpass desuperheater for control of outlet temperature. Twin chain grate stokers are fitted.

The turbo-alternators (Fig. 1) are Parsons 30MW, 3000 r.p.m. machines designed for steam conditions of 600 lb per square inch and 850 deg. Fah., with a 29in vacuum. Twin shell Weir condensers are installed.

The generator voltage of 11kV is stepped up by Parsons or Brush transformers to 33kV for local distribution and to 132kV for being fed into the grid system. For the 33kV circuits the switchgear is oil-immersed and is accommodated in a switch-house. The 132kV switchgear is installed in an outdoor substation to the south-west of the main buildings. The main switchgear was supplied by Ferguson Pailin, Ltd.

The building of this station has been taken through the design and construction stages by the headquarters staff of the B.E.A. under its chief engineer, Mr. V. A. Pask. The main consultants are Messrs. Preece, Cardew and Rider and the civil engineering consultants are Sir Alexander Gibb and Partners.

Roosecote Power Station

The new Roosecote power station is 2 miles south of Barrow in Furness on a site adjoining Roosecote Marsh, where work was started under the auspices of the Barrow Corporation Electricity Department and was taken over by the British Electricity Authority in 1948. Basically the station is similar to the Bold "A" station in the Merseyside and North Wales Division, both installations having been designed by the consultants, Messrs. Merz and McLellan.

Steam is generated in four 300,000 lb per hour corner-fired p.f. Yarrow boilers working at 600 lb per square inch and 850 deg. Fah. with feed heating to 345 deg. Fah. Ultimately the generating capacity will be 120MW, made up of four 30MW Metropolitan-Vickers turbo-alternators with Vickers-Armstrongs condensing and feed-heating plant. The alternators generate at 11·8kV and the output is stepped up to 132kV by Metropolitan-Vickers transformers for switching in a new double-bus grid substation which is equipped with Ferguson Pailin bulk oil circuit breakers.

Coal is transported to the station by rail and is unloaded to bunkers or stock by two wagon tipplers and a system of belt conveyors supplied by Robert Demster. A Beaumont drag scraper plant serves for coal handling on the stockpile. Ash and dust are removed from the boilers and electrostatic precipitators by a B.V.C. wet system and pumped to

fill large sludge lagoons on Roosecote Marsh.

The site also favours the adoption of "pond cooling" for the circulating water, which is drawn from and returned to Cavendish dock by four 23,000 gallon per hour Allen pumps and a duplicate system of 5ft diameter steel pipelines about 1000ft long.

The first two generating sets making up the first half of the station are commissioned and work is in progress on the second half.

Semi-Outdoor Boilers

The importance of economy in the cost of new works is emphasised by the very considerable scale of the British Electricity Authority's construction programmes. For instance, the capital contracts for power stations alone approved by the B.E.A. in 1952–53 amounted to £96,000,000.

One method of effecting capital savings is by the use of semi-outdoor construction for part, at least, of the power station and the first of the B.E.A. stations to embody this idea (which originated in the U.S.A. and has been adopted by oil companies in this country and elsewhere) is at Ince, in the Wirral Peninsular of Cheshire.

This power station is designed on the unit principle and each of the four units will comprise a 60MW hydrogen-cooled turbo-alternator, a 550,000 lb per hour semi-outdoor boiler, with steam conditions of 900 lb per square inch and 900 deg. Fah., and a concrete cooling tower. The first set is due to be commissioned this year.

The design of the station was discussed in a paper*, abstracts of which were reproduced in our issue of December 18, 1953, pages 806–809. Apart from the operating areas around the combustion chambers and steam drums which are enclosed with sheeting to provide weather protection for the operating staff, the boilers stand in the open air.

As stated in the paper, the capital economies to be expected from such a semi-outdoor design are difficult to evaluate since site conditions affect the accuracy of any comparison. For example, in comparing the civil engineering costs in pounds per kilowatt at Ince and at a contemporary orthodox station, there was a saving of £0·577 on structural framework and of £1·240 on the superstructure. Despite the obvious saving in weight of superstructure the foundation costs were £1·023 higher at Ince, because of differences in the local site conditions. Nevertheless, the author of the paper concludes that the capital savings associated with semi-outdoor design may well exceed £1 per kilowatt installed.

The Merseyside and North Wales Generating Division of the B.E.A. is acting as consultant for this station and the main civil engineering contractors are Holland Hannen and Cubitts, Ltd.

Another new power station in which the boilers will be partly exposed is Willington "A," which is to be built near Derby. Design work has been started on this station, which will use a 1500 lb per square inch, 1050 deg. Fah. "straight" cycle to supply steam to four 100MW turbo-alternators, the first of which is programmed for 1956.

Pimlico District Heating

Details of the results obtained from the Pimlico district heating scheme since it went into service early in 1951 were given in a recent paper.† It may be recalled that the scheme provides for the supply of heat from Battersea power station to neighbouring blocks of flats on the other side of the river.

In Battersea power station steam is supplied from the main range to two 1350kW back pressure generating sets which exhaust into a heat exchanger at 17 lb per square inch abs. and 304 deg. Fah. at full load. In this heat exchanger the temperature of the circulating water from the district heating system is raised from about 130 deg. to 216 deg. Fah. before the water is pumped back to the flats, through mains below the river. On the Pimlico site the mains are connected to a hot water storage vessel and a pump-house, whence the hot water is circulated by distribution mains to provide the various blocks of flats with space heating and domestic hot water.

In the paper to which we refer the Pimlico scheme was examined in relation to the ratio R of the electrical energy sent out to the heat energy sent out. It was suggested that, by improving the operating conditions, the ratio R could be raised from 0·17 to 0·27 with a saving in cost of heat delivered to the consumer of 1d. per therm and a saving of more than 1000 tons of coal per annum under the present conditions of heat supply at Pimlico.

The present heat consumption in the Pimlico district heating system is 1,200,000 therms per annum, but it is estimated that the ultimate annual consumption will be about 2,000,000 therms when the dwellings served will include 2000 flats in the Pimlico, Cambridge Street and Warwick Way housing estates of the Westminster City Council, besides the 1220 flats in Dolphin Square. The corresponding saving in coal would then be about 3000 tons per annum. Taking account of the elimination of open fires, and "other thermally inefficient methods of heating," the paper concluded that the total saving of coal by the Pimlico District Heating Undertaking would exceed 10,000 tons per annum for the same quantity of heat supplied.

In a discussion of possible future developments the paper went on to consider the system of double heat storage in which, first, exhaust heat is stored at the generating station or substations for use in the immediate environs and, secondly, electric-thermal storage is used for more remote districts. Such a scheme would lead to complete co-ordination of district heating, electric heating and electricity supply in general. Looking further ahead the time could be visualised when the scarcity and high price of coal in Great Britain would "compel the adoption of heat-electric generation for all electric power stations located at centres of population and industry, where there would be an outlet for the waste heat."

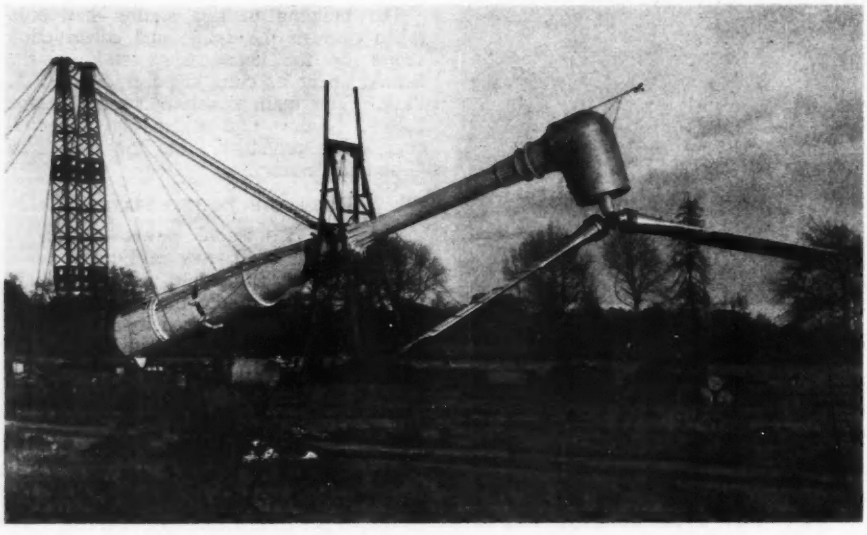


Fig. 2—100kW Wind-Driven Generator during Erection at St. Albans

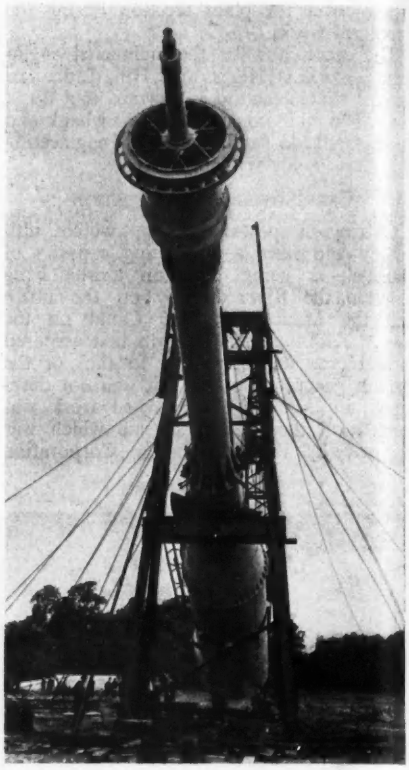


Fig. 3—Supporting Tower of 100kW Wind-Driven Generator

Wind-Driven Generator

Another possible means of saving coal is by the use of wind-driven generators and one of the projects of this kind (The Engineer, February 13, 1953, page 242) is the experimental 100kW plant which has been installed on a temporary site at St. Albans, as illustrated in Figs. 2 and 3.

This installation is an example of the

* "Some Design Features of the Semi-Outdoor Power Station at Ince," by F. H. S. Brown. Institution of Electrical Engineers, London, December 16, 1953.

† "Pimlico District Heating Undertaking" by B. Donkin, A. E. Margolis and C. G. Carrothers. Institution of Civil Engineers, London, December 15, 1953.

Andreau principle in which the wind-driven propeller blades are hollow. The trailing tips of the blades are provided with openings through which air is expelled by centrifugal action as the propeller is rotated by the wind. Air flow is thus induced up a vertical converging duct to the hub of the propeller. The air is admitted through vents at the lower end of the duct and passes through an air turbine which drives a vertical-shaft alternator mounted at the base of the duct. The duct casing forms a support for the propeller and is stayed by twelve guy ropes.

The propeller shaft is carried horizontally in roller bearings 100ft above ground level and is fitted with two light alloy blades which generate an 80ft swept circle. The blades, which are hinged for coning, are maintained at a mean coning angle of 5 deg. A hydraulic system provides automatic adjustment of the pitch so that the rotational speed is kept constant for all values of wind speed between 30 m.p.h. and 65 m.p.h. At rated output the propeller rotates at 95 r.p.m. and the corresponding speed of the generator and turbine is 1000 r.p.m.

A fabricated light alloy structure forms a hub fairing which encloses the feathering mechanism and oil-immersed main bearings. This hub fairing is mounted on roller bearings which allow it to rotate about the axis of the supporting tower, in response to the orientation of the propeller.

The generator is coupled to a 48in diameter, single stage, axial flow air turbine which has a rated mass flow of 1·75 tons per minute. The generator is a 100kW, three phase, 415V, synchronous induction generator with an exciter. Starting from rest, with the exciter circuit open, the machine operates as an induction generator up to slightly more than synchronous speed ; then, when the exciter circuit is closed, the machine pulls into synchronism.

The output of the generator increases from zero at 17 m.p.h. wind speed to full load, 100kW at 30 m.p.h. and then remains constant at wind speeds up to 65 m.p.h., above which the set is shut down. A gust detector is mounted at the upwind end of the hub fairing, as can be seen in Fig. 2, which shows the plant during erection. Since these photographs were taken erection has been completed and mechanical tests have been in progress.

The main contractor for this installation is Enfield Cables, Ltd., the principal subcontractor is de Havilland Propellers, Ltd., and the electrical equipment was supplied by the English Electric Company, Ltd.

(To be continued)

British Iron and Steel Industry in 1953

No. 1

THE principal event in the affairs of the British iron and steel industry last year was its release from nationalisation. For rather more than two years the industry had been publicly owned, as prescribed by the Iron and Steel Act, 1949, but soon after the present Government took office in 1951 it set about implementing its promise to return the iron and steel industry to private enterprise. Thus, after several months of discussion in Parliament, the Iron and Steel Act, 1953, received the Royal Assent on May 14th. The effect of the Act was to repeal the Iron and Steel Act 1949 and to provide for the supervision of the industry by an Iron and Steel Board, presided over by an independent chairman. The repeal of the 1949 Act involved, of course, the dissolution of the Iron and Steel Corporation of Great Britain, in which during the period of public ownership the assets and liabilities of the iron and steel-making companies were vested.

The Iron and Steel Board

A few days after the Act had received the Royal Assent, the Minister of Supply announced the setting up of the Iron and Steel Board, the full-time members of which are Sir Archibald Forbes, the independent chairman ; Sir Lincoln Evans, vice-chairman; and Mr. Robert Shone. In addition, eight part-time members, representative of steel makers, ironfounders, steel consumers, and the trades unions were appointed. The Board's function is to exercise a general supervision over the industry with a view to promoting the efficient, economic and adequate supply, under competitive conditions, of iron and steel products. In particular, the Board is given the responsibility of keeping under review the productive capacity of the industry ; arrangements for procuring and distributing raw materials and fuel ; prices ; arrangements for research, training and education ; arrangements for promoting the safety, health and welfare of the industry's employees, and arrangements for joint consultation on matters other than terms and conditions of employment.

To assist the return of the iron and steel industry to private ownership, the 1953 Act made provision for the appointment of an Iron and Steel Holding and Realisation Agency. This body, which was set up in June under the chairmanship of Sir John Morison, has the normal rights and powers of a holding company. On the " appointed day " the securities held by the Iron and Steel Corporation of Great Britain were transferred to the Agency, which has the task of securing "the return to private ownership of the publicly owned companies whose securities have been transferred."

The Minister of Supply gave July 13th as the " appointed day " under the new Act, and the Iron and Steel Board and the Iron and Steel Holding and Realisation Agency then took up their respective tasks. A month later the Iron and Steel Corporation of Great Britain, which had been established under the 1949 Act, ceased to exist. A few weeks prior to its demise, the Corporation published its second annual report. Although the report did not actually cover any part of last year, it did refer to one or two matters relevant to 1953. It mentioned, for example, the continuing high level of capital development in the British iron and steel industry, and recorded that the general programme of development which outlined the pattern of reconstruction and new building for the next five years had been largely determined. Finally, the Corporation expressed its appreciation of the manner in which the directors, managements, technicians and workpeople of the iron and steel companies under its control had devoted their energies and skill to improving the efficiency of the industry and to promoting increased production.

In the years since the war the British iron and steel industry has passed through a period of uncertainty about its future. Such uncertainty might have had repercussions upon the industry's efficiency and productive effort. Happily, however, that has not been so. Despite the temporary complexities of nationalisation, the industry has progressively improved its output, and has also carried out successfully the first part of its big programme of development and extension. It is reasonable to hope that the year which has just ended has brought to the iron and steel industry, with the passing of the new Act, peace from politics.

Output and Supplies

At the beginning of last year the British Iron and Steel Federation stated that the industry had set itself, as a target for 1953, an output of 17,500,000 tons of steel. In 1952, it will be recalled, a steel production of 16,418,000 tons was achieved. In the last four months of that year record production levels were reached, primarily because of the progress towards completion of the first development programme on which work was started in 1946. New blast-furnaces which were started up during 1952 enabled pig iron production to be increased by 1,000,000 tons, compared with the preceding year.

Throughout 1953 there was further progress. In most months of last year the annual production rates of pig iron and steel were higher than had ever been recorded for the corresponding months of previous years. By the end of the first six months steel production amounted to 9,037,700 tons. By November —the latest month for which figures are at present available—steel production was averaging 363,000 tons a week, or an annual rate of 18,878,000 tons, and pig iron output was averaging 228,500 tons a week, which represented an annual rate of 11,883,000 tons. The total production of steel in the first forty-seven weeks of last year, up to November 28th, was 15,914,000 tons, so that undoubtedly it will be shown, when the output figures for the remaining five weeks have been assembled, that the target of 17,500,000 tons has been reached if not exceeded. Thus, from the point of view of production alone, the iron and steel industry can justifiably claim a highly creditable performance, output last year being nearly 40 per cent higher than in 1946. Furthermore, steel imports last year were lower than in 1952, the average weekly imports in the first nine months of last year being 23,200 tons, against 36,000 tons in the comparable period of 1952.

In addition to the benefits derived from the progress made with the development programme, raw material supplies last year occasioned less anxiety than in preceding postwar years. Home production of iron ore in the first ten months of the year was much the same—about 297,000 tons a week—as in the corresponding period of 1952. But there was a considerable improvement in the supplies of imported ore, arrivals in this country between January and October last averaging 923,800 tons, compared with 817,700 tons in the corresponding months of 1952. Coal and coke supplies were also more satisfactorily maintained. Finally, there was some improvement in supplies of iron and steel scrap. In 1952, the quantity of scrap obtainable from abroad did not amount to more than 695,000 tons. Last year it was estimated that imports of scrap would be round about 500,000 tons, but it seems probable that that amount was exceeded. The British Iron and Steel Federation's scrap campaign was continued throughout the year, and again proved of considerable

assistance in encouraging a better supply of scrap from home sources.

With the sustained improvement in steel production, it followed, of course, that last year supplies of most descriptions of steel were much more in line with demand. Supplies to the home market exceeded 16,000,000 tons, which figure should be compared with 11,800,000 tons in 1946 and an average of 10,400,000 tons in 1937–38. In 1952, home deliveries of steel were 15,890,000 tons, and by the end of that year consumers' and merchants' stocks, which were heavily drawn on in 1951, had been replenished to the extent of 610,000 tons. At the beginning of last year it was realised that the distribution control of iron and steel, which had been reintroduced in February, 1952, could be ended. The statutory control of distribution was actually terminated on May 6th, although the scheme for the distribution of tinplate was continued. But whilst the distribution of steel in general was freed from control, a voluntary scheme was put into operation to assist the more even distribution of steel plates, the supply of which continued to be unequal to the demand. An inter-departmental committee was set up in April to keep under review the needs of the plate-using industries, and there is a group of plate-making firms which acts as a clearing house for making any adjustments in the distribution of plates which the committee considers to be desirable.

This voluntary scheme for steel plate distribution has undoubtedly assisted, although throughout the year the difficulties caused by the shortage of plates were emphasised. In recent years, of course, the demand for plates has increased on account of the high level of shipbuilding activity, railway wagon building programmes, and the expansion of the oil refining industry in this country. At the same time, the output of plates has steadily increased and in 1952 was 51 per cent above the 1937–38 average. But, even with reduced exports, it has not been possible so far to meet the demand. The steel industry is making every effort to ensure that its existing plate capacity is fully utilised and in several places increased. It was anticipated that by the end of the year the output would be approaching 2,500,000 tons, compared with 2,260,000 tons in 1952.

Iron and Steel Prices

A small increase in the controlled prices of British iron and steel was made in March by the Minister of Supply. It averaged between 1 and 1½ per cent—or about 12s. 6d. a ton—and was designed simply to cover the effects of a 10 per cent increase in the price of coal which was also made in March. In recording this minor increase it is well to bear in mind that, in general, British steel prices continue to be a good deal lower than those of other European or American producers. As the British Iron and Steel Federation pointed out some months ago, the relatively low level of steel prices in this country has been an important factor in the post-war economy. Nevertheless, the question does arise as to whether heavy steel prices at present are properly related to true long-term production costs.

Development Programmes

As mentioned earlier in this review, the various development and expansion schemes provided for in the iron and steel industry's 1946 programme were virtually completed last year. When that programme was initiated it was estimated that the cost entailed would be £168,000,000. By the beginning of last year the sum expended on new plant and buildings was approaching £400,000,000 (at 1952 prices). On a comparable basis (i.e. 1945 prices) this was about 17 per cent above the original estimate. The developments already carried out have contributed substantially to greater productivity in the industry, the increase in productivity in steel melting and rolling being about 25 per cent between 1946 and 1952.

The second post-war development programme has been designed to cover the five-year period up to the end of 1957, by which time, it is estimated, the total annual demand for steel is likely to be about 21,000,000 tons. Home steel production is therefore to be increased to approximately 20,500,000 ingot tons a year. In drawing up the second programme no imports of scrap and pig iron were assumed, the increase in steel production being based entirely on pig iron expansion to an output of 15,000,000 tons a year. The whole of the increase in coke requirements is to be provided by the expansion of coke ovens at iron and steel works. The developments envisaged by the new plan are to be concentrated mainly at the new sites and plants established under the first plan. This, it is pointed out, should enable capacity to be extended at a lower cost per ton of additional output than was possible in the first development programme. It should be added that the total cost of the works included in this second plan has been put at around £250,000,000 at 1952 prices.

Development Work in 1953

In Plate 3 we illustrate two examples of development work completed in the iron and steel industry last year. The upper view shows the new melting shop which has been erected at the Lackenby works of Dorman Long and Co., Ltd., Middlesbrough. This company's post-war development programme was designed to be carried out in three stages. The first stage included the ore unloading, ore preparation and sinter plants at the Cleveland works. The second stage, which was nearly complete by the end of last year, comprises the basic open-hearth steel works at Lackenby, which has been designed for an annual output of 625,000 tons of ingots. The equipment of the Lackenby melting shop includes four 360-ton tilting furnaces and two 60-ton active mixers. By the end of the year these were all in operation and a fifth furnace, which is being installed, is expected to be in commission in from two to three months' time.

The second stage of the Dorman Long project also included the duplication of the ore grading and ore preparation plant at the Cleveland works. In addition, the boiler plant at these works was increased last year by two Thompson boilers working at a pressure of 450 lb per square inch. Yet another addition to the facilities at the Cleveland works is a new ladle repair shop, which was completed last year.

The third stage of the Dorman Long development programme was put in hand last year. The principal item in this part of the programme is the installation at Lackenby of a universal beam and heavy section mill, which is to have an annual output of 400,000 tons of rolled products. Other items of particular importance in this third part of the programme are two major schemes for expanding the company's iron and coke production. At the Cleveland works two blast-furnaces, each with a hearth diameter of 27ft 6in, are to be built. Their joint capacity will be 750,000 tons of iron a year. The foundation work for these two furnaces was well on the way to completion by the end of the year, and a start had been made on the erection of the stoves. The other major scheme at the Cleveland works is the building of a new coke oven plant, which will carbonise 1,300,000 tons of coal annually. Work on the foundations for the ovens is well advanced. Other projects at the Cleveland works, to be undertaken in the third stage of the programme, are the installation of a new blooming mill, additions to an existing blooming mill, and a new section mill. The latter is to have an annual output of 175,000 tons of medium sections. A high-capacity rod and bar mill, with an annual capacity of 175,000 tons, and expanded capacity for wire production and processing, is also to be installed.

The capital expenditure involved in the first two stages of the Dorman Long programme amounts to about £14,000,000, while the amount estimated for the third stage is approximately £36,000,000. When all the works are completed the company anticipates that its production capacity will be : blast-furnace coke, 1,481,000 tons ; pig iron, 1,690,000 tons ; steel ingots, 2,315,000 tons ; and rolled steel, 1,879,000 tons.

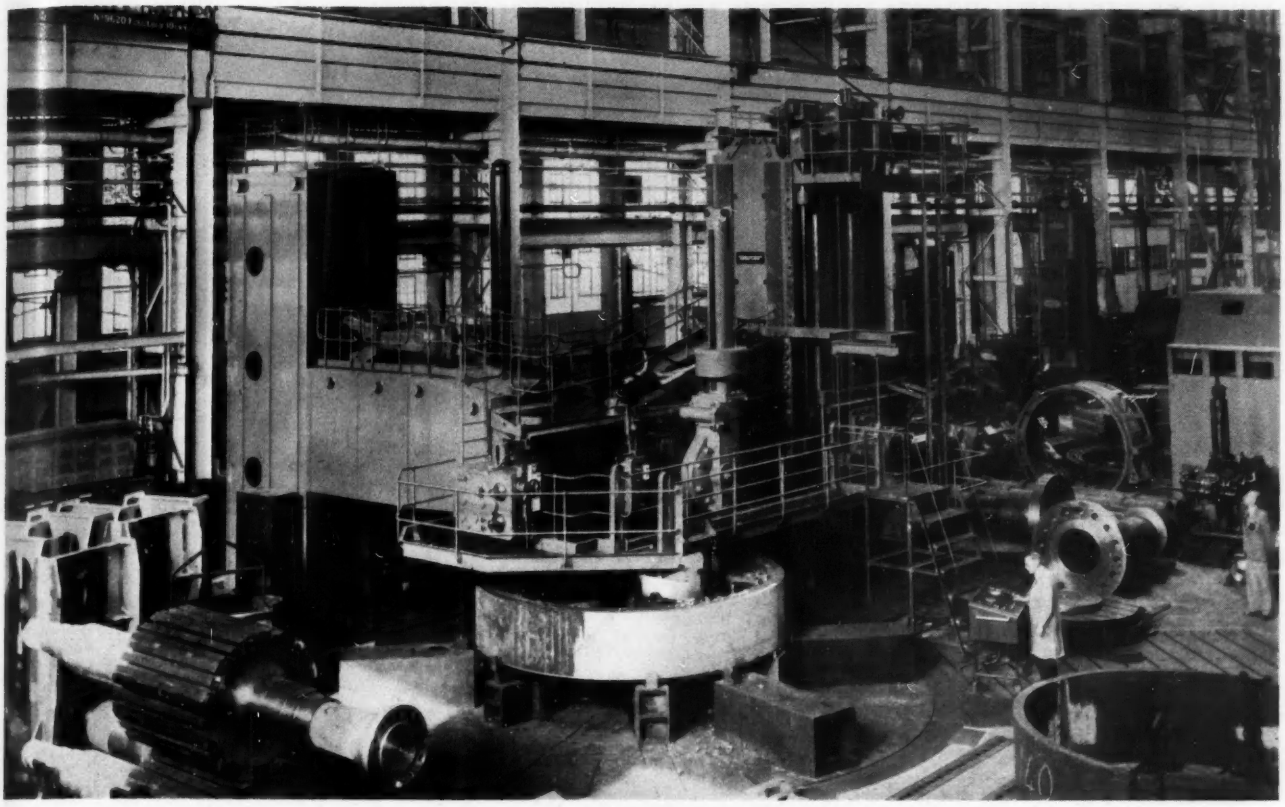
The lower view on Plate 3 shows the new blast-furnace at the Hawarden Bridge Steel Works at Shotton, of John Summers and Sons, Ltd. Its hearth diameter is 27ft, the daily output of iron being more than 1000 tons. Prior to the war the steel-making capacity at Shotton consisted of two steel plants which depended for their supplies of pig iron and scrap upon a subsidiary company and outside sources. Continuous hot and cold strip mills were completed in 1939, and after the war a programme of expansion was begun in order to make the works into a fully integrated steel plant. The first stage of the work, which was completed in the early part of last year, included the erection of a new melting shop with eight furnaces, each of 150 tons capacity, the blast-furnace already mentioned, a coke oven plant with two batteries of forty-four ovens each, together with a by-product plant.

Some of the equipment at Shotton has already been described in these pages. A comprehensive scheme was devised for the automatic control of the eight open-hearth furnaces in the new melting shop. In particular, provision has been made for controlling the maximum roof temperature and the furnace pressure, and for the automatic reversal of the furnaces. The indicating, recording and control equipment for each furnace is housed in a control cubicle which is pressurised to keep out the dust-laden steel works atmosphere. The equipment, which was supplied by Tinsley (Industrial Equipments), Ltd., was fully described in The Engineer of March 27, 1953. We also described in our issue of April 3rd the four ladle cranes, supplied by the Wellman Smith Owen Engineering Corporation, Ltd., for the melting shop. Two of these cranes have a lifting capacity of 250 tons and two are of 125 tons capacity. Another interesting installation at Shotton is the coal blending plant, designed on the Robins-Messiter system, and installed by the Fraser and Chalmers Engineering Works of The General Electric Company, Ltd. The plant, which has a handling capacity of 300 tons an hour, was described in our issue of April 10th last.

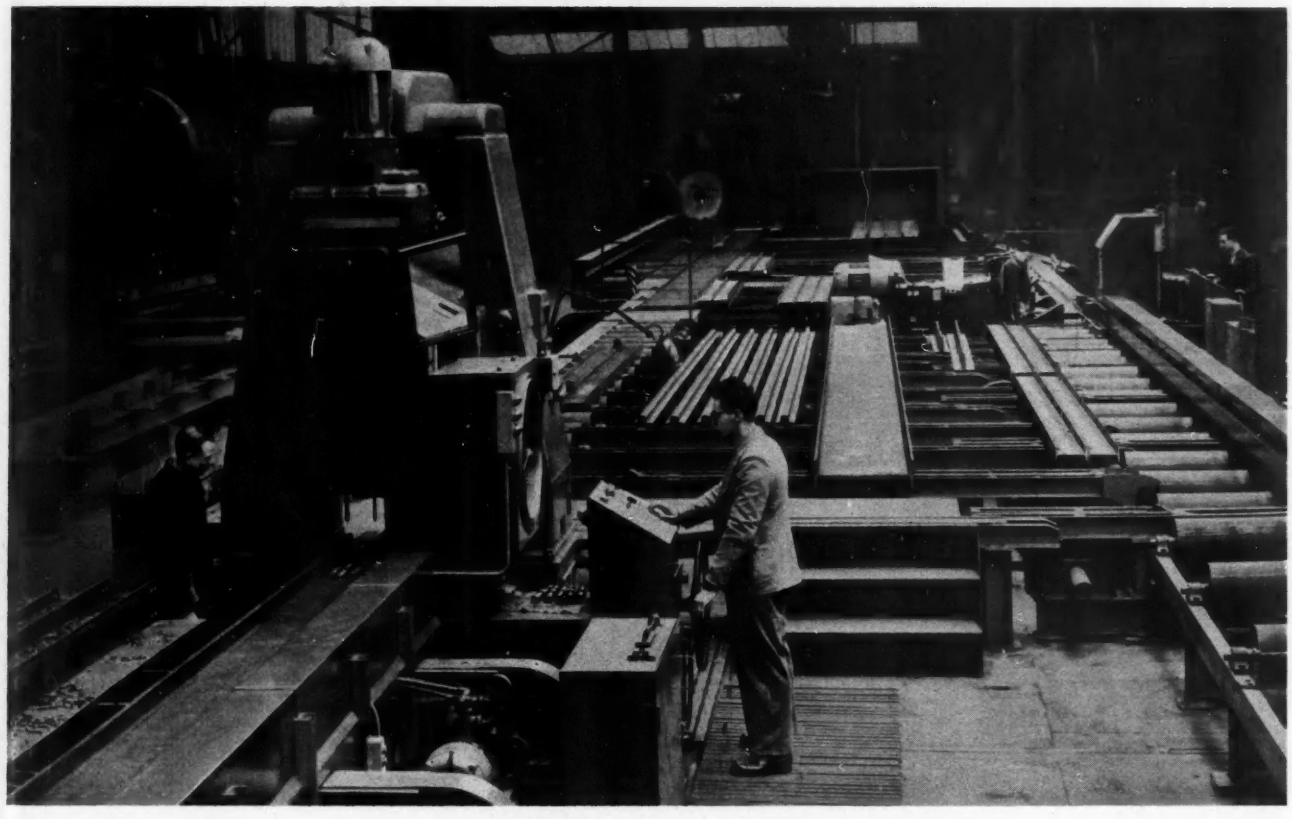
The second stage of the developments at Shotton, which is now in progress, involves the duplication of the blast-furnace plant and the erection of a further eighty-eight coke ovens, together with the necessary by-products plant. The existing melting shop, it may be added, is capable of being extended by a further four furnaces. It is interesting to note that when the Hawarden Bridge Steel Works at Shotton were started in 1896 they occupied an area of 6 acres. The area now occupied by the works is 530 acres.

(To be continued)

TWO MACHINE TOOLS OF 1953

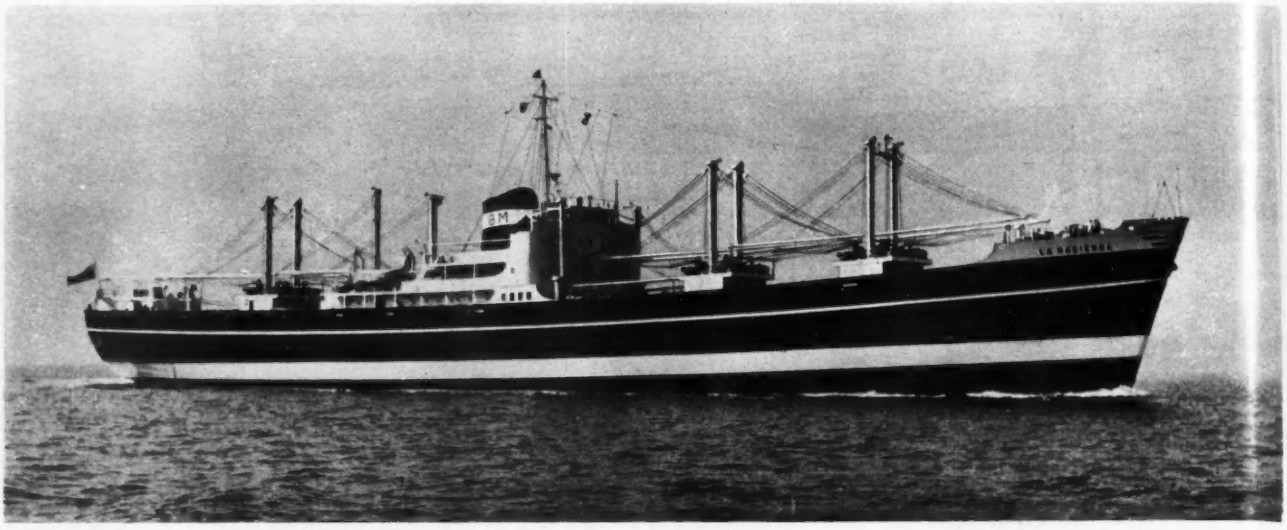


Large Boring Mill at B.T.H. Works

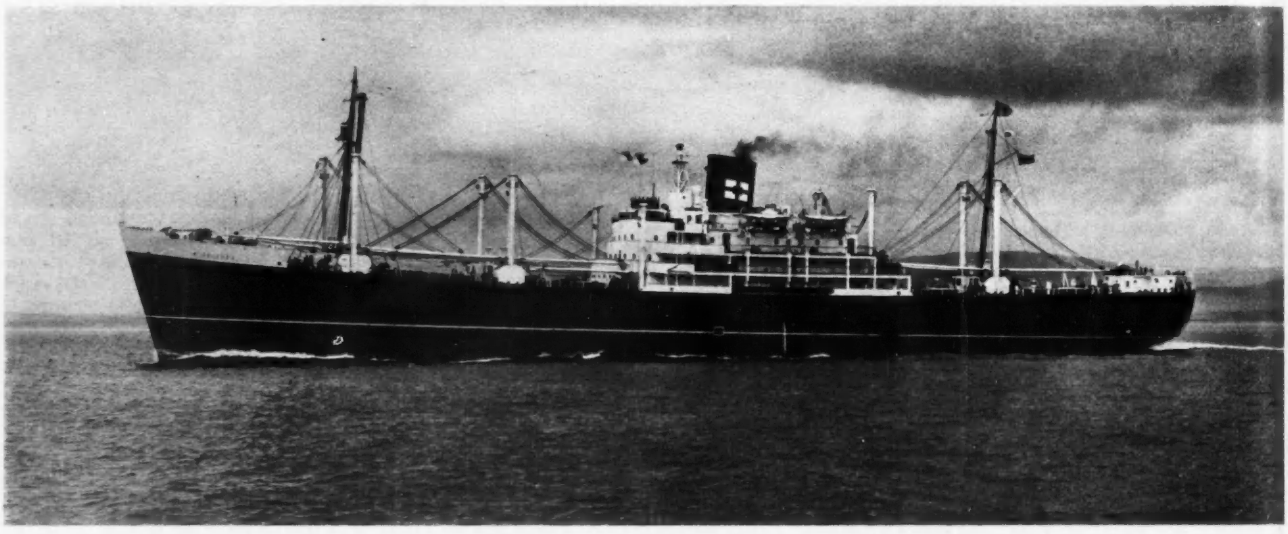


Structural Steel Drilling Plant at Boulton and Paul Works

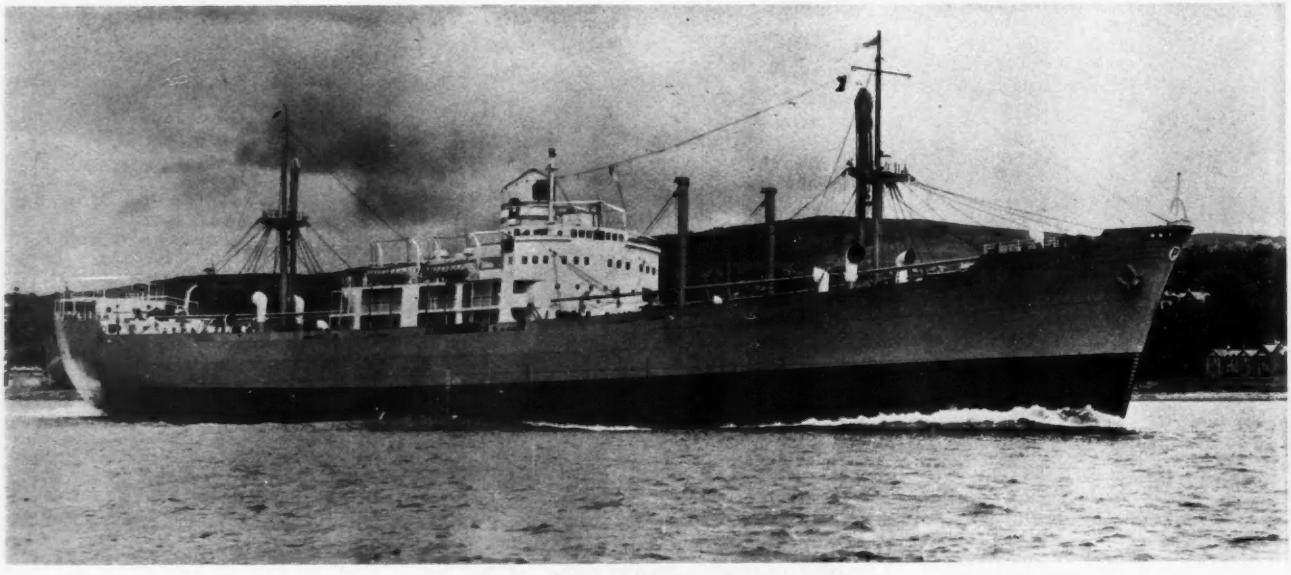
CARGO SHIPS OF 1953



Motor Vessel "La Hacienda"

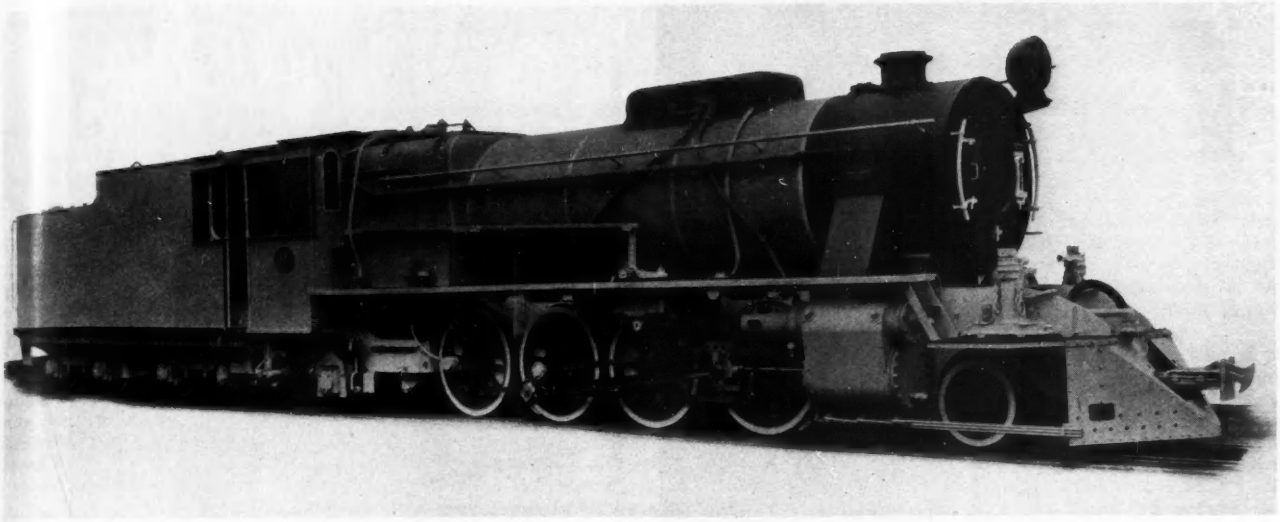


Motor Vessel "Middlesex"

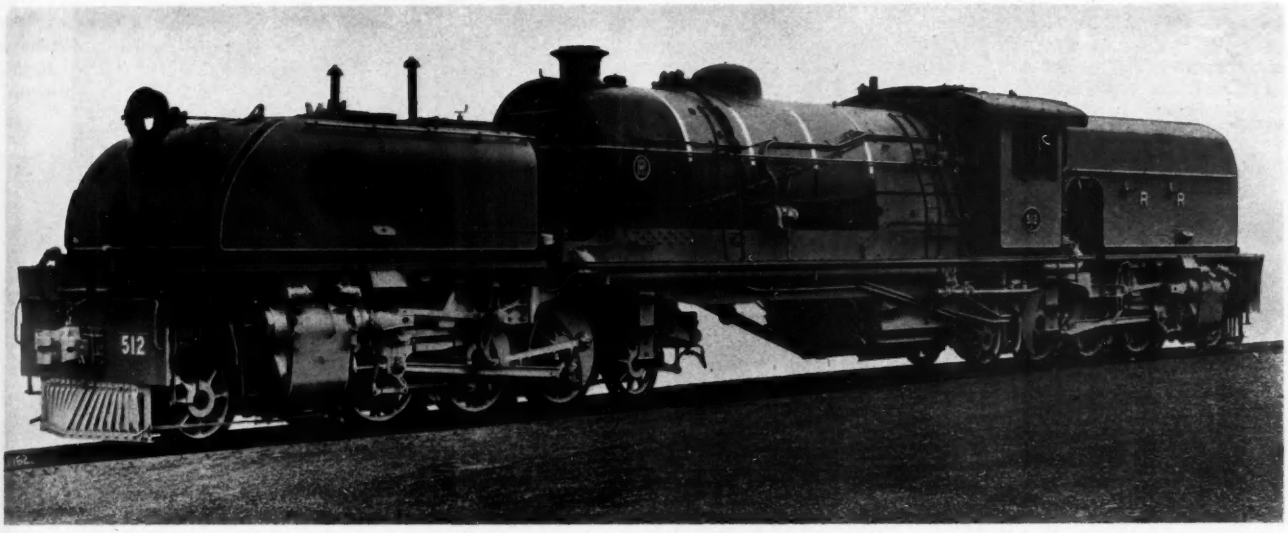


Steam Ship "George"

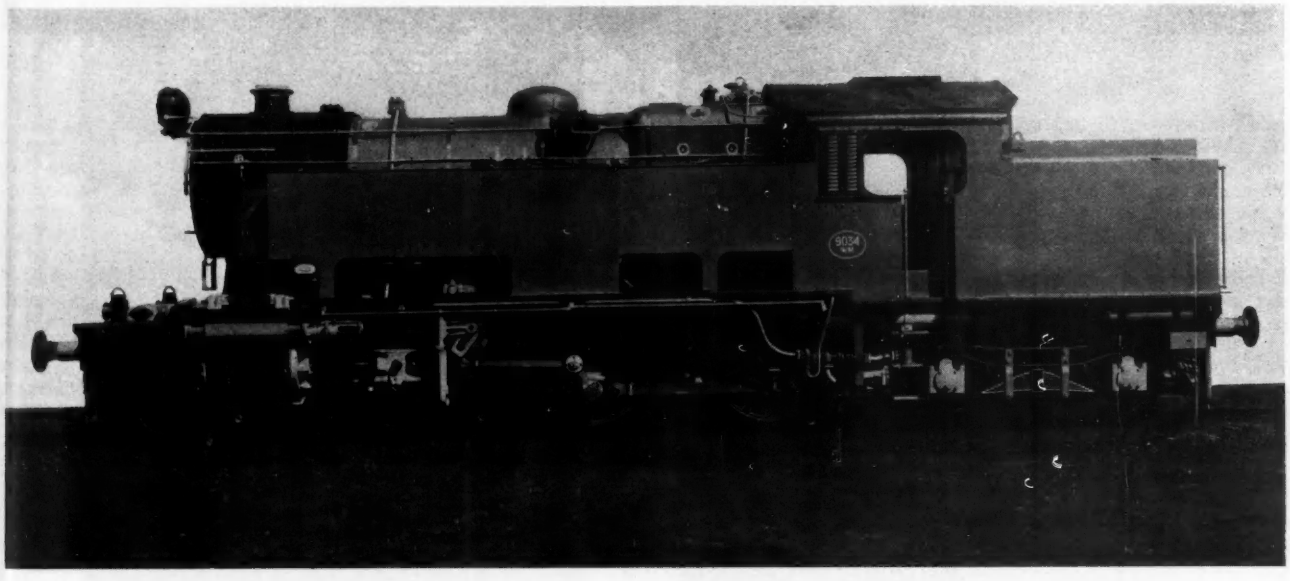
LOCOMOTIVES OF 1953



2–8–2 Locomotive for Iraq



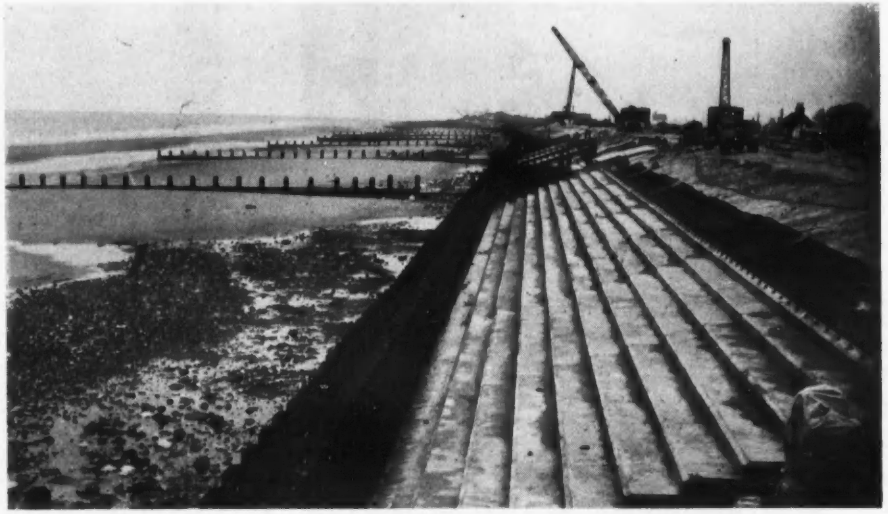
2–6–2+2–6–2 Locomotive for Rhodesia



2–6–4 Tank Locomotive for India

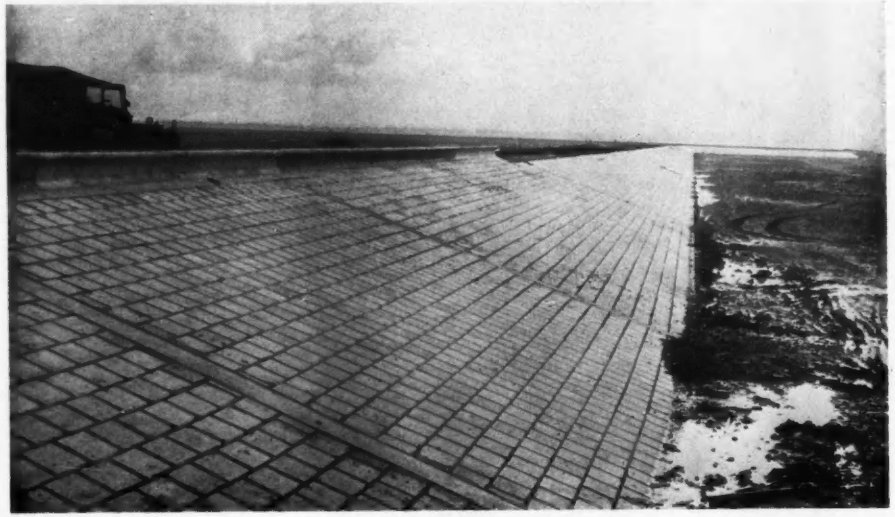
EAST COAST SEA DEFENCE WORKS OF 1953

Permeable Revetment at Caister, Norfolk



Construction of Reinforced Concrete Stepped Wall near Sandilands, Lincolnshire

Sea Wall and Groynes, Kessingland, Suffolk



Embankment Faced with Precast Blocks, Graveney, Kent

Naval Construction in 1953

By RAYMOND V. B. BLACKMAN

No. I

Great Britain

THE year 1953 was notable for the near completion, after so many years, of three large warships which might in these days be placed in the capital ship category —namely the intermediate aircraft carriers of the " Centaur " type—the acceptance from the builders of several more units of the " Daring " class, some visible results in the new frigate construction programme, and the full or limited conversion of a considerable number of destroyers into fast anti-submarine frigates. The year was also marked by the emergence, from the yards of many firms specialising in the building of the smaller types of warships, of large numbers of coastal minesweepers, inshore minesweepers, fast patrol boats, and seaward defence boats, which collectively constitute the first fruits of the rearmament programme.

Aircraft Carriers

The highlight of naval construction during the year was the launch of H.M.S. " Hermes," an aircraft carrier built at the Barrow-in-Furness yard of Vickers-Armstrongs, Ltd. This long-overdue ship, which was laid down as long ago as June 21, 1944, slid into the Walney Channel on February 16th after nearly nine years on the stocks.

It has been officially stated that the " Hermes " gives her name to a class of four light fleet aircraft carriers, but in fact she will be considerably different from her three originally planned sister ships, " Albion," " Bulwark " and " Centaur " (Fig. 1), and she hardly falls into the category of a light carrier. Her dimensions are officially stated to be 741ft 6in in extreme length and 650ft between perpendiculars, with a beam (extreme breadth) of 90ft. Her standard displacement is unofficially expected to be well above 20,000 tons with a full load displacement of about 26,000 tons. She will carry about forty-five aircraft according to type and size, and she will be armed with thirty-five 40mm Bofors anti-aircraft guns. Her main propelling machinery, consisting of Parsons geared steam turbines turning two shafts, is by Vickers-Armstrongs, Ltd., the boilers being of the Admiralty three-drum type, and it is anticipated that she will develop a maximum of some 80,000 s.h.p., equal to a speed of about 30 knots.

In a number of ways the " Hermes " will be better than the earlier ships of her class, since she will incorporate new equipment and arrangements. An important feature being embodied in the " Hermes " is the angled deck, which enables aircraft to land without any possibility of overrunning the catapult operating positions or aircraft parked at the forward end of the flight deck. The " Hermes " will, in fact, be the first British aircraft carrier to incorporate three post-war developments, namely, the angled deck, the steam catapult and the side lift. These will remove many of the limitations hitherto considered inevitable in an aircraft carrier, and will enable her to operate efficiently and at increased tempo the fastest, heaviest and most powerful naval aircraft now available or expected to come into service in the near future.

Both the angled deck and the steam catapult are recent British inventions. The former is an oblique arrangement of the flight deck which permits aircraft to land on at an angle of 8 deg. to 10 deg. (angles tried out in other ships have varied between 8 deg. 9 min to 10½ deg.) off the centre line of the ship, so that should they fail to pick up or if they overshoot the arrester wires they can fly off over the port side. The " Hermes " was at a comparatively early stage of construction when the angled deck was proved and full advantage can be taken of the delay in her building to embody the full and complete angled deck arrangement. The steam catapult with which she will be equipped is a high-powered sling shot driven by steam from the main boilers, and this catapult can, if necessary, launch heavy aircraft into flight even while the ship is lying at anchor or alongside the jetty.

The " Hermes " has both steam and diesel-driven electric generators. These are connected to a ring main system from which supplies for power and lighting are distributed throughout the ship. The standard of illumination will conform with the best practice on shore. The illumination of living spaces and offices will be effected by fluorescent lighting. The ship is being fitted with an automatic telephone system and a broadcasting network to cover all messing and working spaces. The new carrier will take a wartime complement of about 1400 officers and men, most of whom will sleep in bunks instead of hammocks. Originally projected under the proposed name of " Elephant," the ship was given the name " Hermes " when a sister ship of that name was cancelled at the end of the second world war. She is the tenth vessel of her name, the last " Hermes " having been an aircraft carrier of only half her displacement (10,850 tons), sunk by Japanese aircraft off Ceylon on April 9, 1942.

Of the remaining three of the four ships which originally sprang from the same design, of which the " Hermes " is officially the name ship of the class, and formed part of the wartime construction programme, two were completed as far as their builders' original instructions were concerned (before the advent of the angled deck) and work on the fitting out of the other continued throughout the year. The " Centaur," which was built by Harland and Wolff, Ltd., Belfast, having been laid down on May 30, 1944, and launched on April 22, 1947, was the first to carry out final sea trials in 1953 and to be delivered to the Admiralty on the usual provisional acceptance basis, but her entity as a complete and sea-borne naval vessel was short-lived, for in October, 1953, she was taken in hand by H.M. Dockyard, Portsmouth, for the installation of a modified or " interim " angled deck arrangement which it is understood will be at an angle of 5½ deg. to the centre line, instead of the full angle of 10½ deg. which can be embodied in ships in early stages of construction, and may involve alterations to the starboard as well as to the port side of her flight deck.

The " Albion," which was begun on March 23, 1944, and left the slip on May 6, 1947, was also completed towards the end of the year. With main propelling machinery by the Wallsend Slipway and Engineering Company, Ltd., this ship was built by Swan, Hunter and Wigham Richardson, Ltd., Wallsend-on-Tyne, who have also been entrusted with the installation of the angled deck and all the alterations involved. The " Bulwark," the construction of which was not so far advanced, her keel having been

Fig. 1—H.M.S. " Centaur "

laid on May 10, 1945, so that she did not come off the stocks until June 22, 1948, a year after her two sisters, was the first of the two in which it was decided to install the angled deck. This ship, which is also being built by Harland and Wolff, Ltd., Belfast, is officially expected to be completed in 1954.

Initially conceived in the improved light fleet aircraft carrier category, all three of the above ships are considerably enlarged vessels, compared with their forebears, with propelling machinery of nearly twice the power of the original light fleet carrier type, designed to give an increase in speed of about 5 knots, thus correcting the inherent faults of the inadequate 13,190 to 14,000-ton carriers and bringing them more into line with modern fleet aircraft carrier requirements. Improvements incorporated during the long period of their construction, however, as a result of successively amended designs since they were first projected, have increased the original standard displacement figure from 18,300 to 20,180 tons, and they will displace 25,760 tons at full load. With an overall length of 737ft, and a length between perpendiculars of 650ft, they have a hull beam of 90ft and draw 26ft 3in of water. The main propelling plant comprises a two-shaft arrangement of Parsons geared turbines taking steam from Admiralty three-drum boilers and designed to develop 76,000 s.h.p., equal to a speed of 29·5 knots. The "Albion," "Bulwark" and "Centaur" were designed to carry forty-five aircraft, and they are armed with thirty-two 40mm Bofors A.A. guns. The shape of the stern in these ships, a flat V-shaped transom, differs from that in earlier aircraft carriers.

The construction of the large fleet aircraft carrier "Ark Royal," which will be the biggest aircraft carrier ever built in Great Britain, seemingly goes on for ever. This ship was first projected under the name "Irresistible" quite early in the second world war, but following the sinking of the first fleet aircraft carrier "Ark Royal" in November, 1941, the name was allocated to the much larger vessel now being completed. It is now getting on for eleven years since the keel of the "Ark Royal" was laid on May 3, 1943. Launched from the Birkenhead slipway of Cammell Laird and Co., Ltd., on May 3, 1950, exactly seven years to the day afterwards, she was originally scheduled to be completed at the end of 1952, but various adjustments in design and modifications incorporated in her in the light of current or future requirements retarded her construction, and at the end of 1953 she was still fitting out. Now that it has been decided to install the angled deck in her the final completion of the ship will be still further delayed until the end of 1954.

With a standard displacement of 36,800 tons as originally designed, which will be increased to more than 46,000 tons at full load, the "Ark Royal" has an overall length of 803ft 9in and a length between perpendiculars of 720ft with a beam of 112ft 9in and a maximum draught of 36ft. She will carry eighty to 110 aircraft according to size and type, and she will be armed with sixteen 4·5in dual-purpose guns and fifty-two 40mm A.A. weapons. Her main propelling machinery comprises eight Admiralty three-drum boilers supplying super-heated, high-pressure steam to a four-shaft arrangement of Parsons single-reduction geared turbines designed to develop an aggregate of 152,000 s.h.p. and to give a speed of 31·5 knots at deep load. The ship is of 90 per cent welded construction and her compartmentation and damage control arrangements are exceptionally complete.

Work on the remaining two of the seven aircraft carriers which constitute the back-log of the wartime construction programme, namely, the two light fleet aircraft carriers "Hercules" and "Leviathan," is still suspended. Built at the High Walker Naval Yard of Vickers-Armstrongs, Ltd., Newcastle on Tyne, with main engines by Parsons, the "Hercules" was begun on October 14, 1943, and left the stocks on September 22, 1945 but work upon her was stopped in May, 1946, and she is laid up at Faslane. The keel of the "Leviathan" was laid on October 18, 1943, at the Wallsend-on-Tyne Yard of Swan, Hunter and Wigham Richardson, Ltd., and she took the water on June 7, 1945. This ship was also suspended in May, 1946, when structurally almost completed and 80 per cent fitted out, propelling machinery having been supplied by the Wallsend Slipway and Engineering Company, Ltd., and she was laid up in H.M. Dockyard, Portsmouth, where she has remained ever since. The contracts for both ships, though so far advanced, were cancelled.

But amended figures concerning the "Hercules" and "Leviathan," which were designed for a standard displacement of 14,000 tons with a full load displacement of 19,000 tons, were officially given in the 1953–54 Navy Estimates. The overall length was stated to be 694ft, with a length between perpendiculars of 630ft and a beam of 80ft. The armament was stated to be thirty-two guns (of 40mm calibre). The main propelling machinery consists of a two-shaft arrangement of Parsons single-reduction geared turbines supplied with steam from four Admiralty three-drum boilers and developing 42,000 s.h.p., equal to a designed speed of 24·5 knots. The intended capacity of these ships was thirty-five aircraft with a war complement of 1343 officers and ratings.

Cruisers

In the 1953–54 Navy Estimates it was also stated that constructional work on the three long-delayed cruisers of the "Tiger" class remained suspended, although work in relation to the preparation of equipment was being progressed, and that the future armament, which was under review, and equipment of these ships was dependent on research then in progress. It now seems certain that these ships will easily break the record for the length of time taken to construct any ship of the cruiser category. The keel of the "Tiger" was laid at the Clydebank yard of John Brown and Co., Ltd., as long ago as October 1, 1941, and she was launched on October 25, 1945. But work was stopped in July, 1946, and she was laid up at Dalmuir. The "Defence" was begun on June 24, 1942, by Scott's Shipbuilding and Engineering Company, Ltd., Greenock, and she slid down the ways on September 2, 1944, but work upon her, too, was suspended after the war, her contract was cancelled, and she is laid up in the Gareloch. The "Blake," laid down by the Fairfield Shipbuilding and Engineering Company, Ltd., Govan, Glasgow, on August 17, 1942, left the stocks on December 20, 1945, but her construction was also stopped in 1946 and she was laid up at Greenock. The only details released officially are the overall length of 555ft 6in, with 538ft between perpendiculars and beam of 64ft.

"Daring" Class

During 1953 three more of the new ships which have outgrown the destroyer category were accepted into H.M. service. The "Dainty" was laid down as a destroyer on December 17, 1945, launched on August 16, 1950, and completed in March, 1953. She was an unconscionable time under construction for such a comparatively small ship, but not through the fault of her builders, J. Samuel White and Co., Ltd., Cowes, Isle of Wight. Even when completed she did not join the Fleet and at the time of writing she appears to be listed under ships of the Reserve Fleet, an unusual state for a new ship of her category. She cost £2,143,000. The "Decoy" (ex-"Dragon" see Fig. 2), built by Yarrow and Co., Ltd., Scotstoun, was begun on September 22, 1946, and took the water on March 29, 1949, being completed on April 28, 1953, while the "Delight" (ex-"Disdain," ex-"Ypres"), the keel of which was laid on September 5, 1946, at Govan by the Fairfield Shipbuilding and Engineering Company, Ltd., who sent her down the ways on December 21, 1950, was delivered to the Royal Navy in October, 1953, and was scheduled to join the Mediterranean Fleet towards the end of the year. Of the eight ships of the "Daring" class only one now remains to be completed, namely, the "Diana" (ex-"Druid"), which was laid down on April 3, 1947, by Yarrow and Co., Ltd., Scotstoun, who launched her on May 8, 1952. She is still fitting out. In May, 1953, the Admiralty were at pains to make it known that they wished to suppress the designation of destroyers as applied to the "Daring" class and to refer to them by the unwieldy description of "Daring Class Ships."

With a standard displacement of 2610 tons and a full load displacement of 3700 tons, the "Daring" class ships have an overall length of 390ft, a length between perpendiculars of 366ft, a wide beam of 43ft, and a maximum draught of 12ft 6in. Their armament consists of six 4·5in dual-purpose guns in twin turrets, two forward and one aft, six 40mm A.A. weapons, ten 21in torpedo tubes in two pentad nests, and a squid type triple-barrelled anti-submarine mortar. The main propelling machinery comprises Foster-Wheeler or Babcock boilers and two sets of Parsons double-reduction geared turbines of advanced design turning two shafts and designed to develop an aggregate of 54,000 s.h.p., equal to a speed of 34·75 knots. The steam conditions are the highest yet used in ships of the Royal Navy, the boilers having been designed for superheat control. In some of the ships the electrical installation operates at 440V, three-phase, 60 c/s, while the others use 220V d.c. All the ships are of welded construction.

Frigates

Turning from the outstanding units of the emergency war programme to ships of the post-war naval rearmament programme, several of the twenty-four frigates which were to be built under a new schedule spread over three years have at last materialised in various stages of construction. These new frigates are of four differing types according to the duties required of them, two types for anti-submarine work, a third type for anti-aircraft duties, and a fourth for aircraft direction. The First Lord of the Admiralty, introducing the Navy Estimates for 1952–53, explained why several types of frigates were necessary and why it has not been possible to produce an all-purpose vessel. The answer is that modern equipment is now so great that it will not go into one vessel of a reasonable size. No one ship, therefore, can carry all, but, at the same time, each type can do some of the work of the other types. This specialisation in the particular employ-

ment and function of warships is now much more a prime factor in their design, contracting, construction, equipment and cost than their broad category would indicate.

H.M.S. "Salisbury," the first of the new aircraft direction frigates named after cathedral cities, and the first new frigate of any kind in the post-war programme, was launched at H.M. Dockyard, Devonport, on June 25, 1953, Lady Mansergh, wife of Admiral Sir Maurice J. Mansergh, K.C.B., C.B.E., Commander-in-Chief, Plymouth, having performed the naming ceremony. Begun on June 23, 1952, her construction was all-welded and largely prefabricated. The ship has an overall length of 340ft with a beam of 40ft.

Fig. 2—"Daring" Class Ship H.M.S. "Decoy"

She will be powered by Admiralty standard range diesel engines, and her armament will consist of two 4·5in guns and two smaller weapons. Sister ships, the "Chichester" and the "Llandaff," are being built by the Fairfield Shipbuilding and Engineering Company, Ltd., and R. and W. Hawthorn Leslie and Co., Ltd., respectively.

H.M.S. "Leopard," a frigate of the new anti-aircraft type, was officially begun in H.M. Dockyard, Portsmouth, on March 25, 1953, although, as is the case with many other warships these days, the ceremony to mark the occasion was concerned not so much with the laying of her keel as the token welding together of prefabricated sections which had been assembled on the slip some time before. Large sections of the ship had already been prefabricated and were ready to be swung into position on the stocks. Materials had been assembled round the slip for a considerable time so that once the ship was begun construction could go ahead without delay. This is the first ship built on the big slip at Portsmouth (where battleships have been built) since the cruiser "Hawke" was broken up on the stocks at the end of the war. Three sister frigates, the "Jaguar," "Lynx" and "Puma," are being built by W. Denny and Bros., Ltd., John Brown and Co., Ltd., and Scott's Shipbuilding and Engineering Company, Ltd., respectively. The latter was originally scheduled to carry out trials in June, 1954. These ships are already known collectively as "The Big Cat Squadron." They were all designed from the start for rapid construction by prefabrication methods, and will be all-welded. They will be propelled by diesel engines.

But the greater part of the frigate programme consists of anti-submarine frigates of two types of different striking power. These will be complementary to each other and the simpler vessel will be produced in larger numbers for the same expenditure in resources. The first anti-submarine frigate for the Royal Navy since the end of the second world war, H.M.S. "Dundas," was launched at the Cowes yard of J. Samuel White and Co., Ltd., Isle of Wight, who were also responsible for the manufacture of the main propelling machinery, on September 25, 1953. The "Dundas" is scheduled for trials in May, 1954. This first ship of the second rate or "utility" anti-submarine frigates named after notable naval captains of the past was followed into the water two months later by a sister ship, H.M.S. "Hardy," at the Scotstoun yard of Yarrow and Co., Ltd., Glasgow, who also built the main engines to the design of the English Electric Company, Ltd. Seven other frigates of this class, namely, the "Blackwood," "Duncan," "Grafton," "Keppel," "Malcolm," "Murray," and "Pellew," are being built by John I. Thornycroft and Co., Ltd., Woolston, Southampton (two); J. Samuel White and Co., Ltd., Cowes; Yarrow and Co., Ltd., Scotstoun (two); Alex. Stephen and Sons, Ltd., Govan, Glasgow; and Swan, Hunter and Wigham Richardson, Ltd., Wallsend-on-Tyne, respectively. All these ships have an overall length of 310ft and a length between perpendiculars of 300ft, with a beam of 33ft. They are powered by geared steam turbines of advanced design, and will be armed with three Bofors guns and two three-barrelled anti-submarine mortars. The latter are of the same design as those fitted in H.M.S. "Rocket," one of the first destroyers converted into fast anti-submarine frigates. Each can fire a pattern of large projectiles with great accuracy, and the projectiles can be set to explode at a predetermined depth. These weapons can be trained over a wider arc than any previous types of anti-submarine mortars.

The other type of anti-submarine frigates under construction will be larger and faster and of greater striking power. These ships, which have been classed as first-rate frigates, include the "Scarborough," being built by Vickers-Armstrongs, Ltd., Newcastle on Tyne, with main machinery manufactured by the same firm at Barrow-in-Furness; the "Tenby" and "Whitby," both entrusted to Cammell Laird and Co., Ltd., Birkenhead; and the "Torquay," under construction by Harland and Wolff, Ltd., Belfast. This type has naturally been dubbed the "Seaside" class. Their propelling machinery will include geared turbines, and they will be equipped with the very latest developments in anti-submarine weapons.

Minesweepers

The real first fruits of the rearmament programme—that is, ships completed and commissioned in the Royal Navy—are the new coastal minesweepers of the "Ton" class, of which H.M.S. "Coniston" (Plate 1), built by John I. Thornycroft and Co., Ltd., Woolston, at a cost of £447,000, was the first to be accepted into H.M. service in February, 1953. Since then a number of sister ships have been completed, all with main machinery comprising a two-shaft arrangement of high-speed diesels, standardised to simplify the maintenance problem, manufactured by Mirrlees, Bickerton and Day, Ltd., Stockport. Some seventy-six of this new type of vessel, largely of mahogany construction, have been built, or are building or projected, by sixteen or more builders which, in addition to some of the well-known warship builders, include smaller boat-building yards and also firms which are not normally asked to undertake naval work. Messrs. Thornycroft were selected by the Admiralty to act as "parent" firm for the production of the working drawings for the type of vessel for supply to a group of builders. They were also made largely responsible for the ordering and progressing of materials and equipment and for giving guidance in these matters to other firms of the group. These coastal minesweepers, which are an entirely new type of minesweeper embodying many novel features, have an overall length of 152ft with a length between perpendiculars of 140ft and a beam of 28ft 9in. They are armed with three small guns. Their construction incorporates the use of aluminium, both for the framing and structural castings, the outer bottom being wood planked. The hulls are thus largely of non-magnetic material, and being of similar design are capable of rapid prefabrication. The ships have the latest minesweeping equipment and will operate sweeps against both contact and influence type mines—that is, they will be able to deal with

mines operated magnetically and acoustically. The quarters of the ship's company are not fitted with hammocks, but with berths and are well air conditioned by forced (mechanical) ventilation and heated by electric radiators. An all-electric and well-equipped galley is fitted. The term " coastal minesweeper " signifies that they will be capable of operation in shallow coastal waters and distinguishes them from " inshore minesweepers," which are to be operable in shallow estuarial waters. They were to have been named after birds or insects, but subsequently reverted to numbers and finally were named after villages, all with the suffix " ton."

The seventy-five new inshore minesweepers, which are considerably smaller craft, are subdivided into two types, the " Ham " class and the " Ley " class. Sixty-four of wooden construction are named after villages with the suffix " ham," while eleven of composite construction are named after villages with the suffix " ley." They were to have been named after insects, with a colour prefixing the actual species, but were then known merely by numbers, and finally named after villages. The first vessel of the " Ham " class, namely, the " Inglesham " (Plate 1), was completed in 1953 by J. Samuel White and Co., Ltd., Cowes, the parent firm for the inshore minesweeper type, who were also responsible for the first vessel of the " Ley " class, namely, the " Dingley," the main machinery for which was manufactured by Fodens, Ltd., Sandbach, Cheshire ; but the majority of these new inshore minesweepers were built or are under construction by a score of the smaller shipbuilding yards and yacht and boat-building firms all over the United Kingdom, a wise spread by the Admiralty which will be of immense value if larger numbers of these craft are required in emergency. All the vessels have an overall length of 106ft 5in with a length between perpendiculars of 100ft and a beam of 21ft 2in, and they each mount a small gun in addition to minesweeping equipment. They are flush decked, in contrast to the coastal type, which have a forecastle breaking abreast the funnel just abaft of amidships. The inshore type, an entirely new vessel in the Royal Navy, embody novel features resulting from lessons learned during the war, and in the course of subsequent developments. They were designed to operate in shallow waters such as rivers and estuaries. Quite a number are in commission, sufficient to form a minesweeping squadron at Harwich and Hythe. All are powered by diesel engines, most of which were manufactured by Davey Paxman and Co., Ltd., Colchester, or by Ruston and Hornsby, Ltd., Lincoln, under licence from Davey Paxman. In addition to the seventy-five vessels above, a number of inshore minesweepers will be built in British yards under the United States Navy's offshore procurement programme for allocation to North Atlantic Treaty Organisation countries, the contract having been signed on March 13, 1953. A number of war-built motor launches of approximately the same size are also being converted into inshore minesweepers.

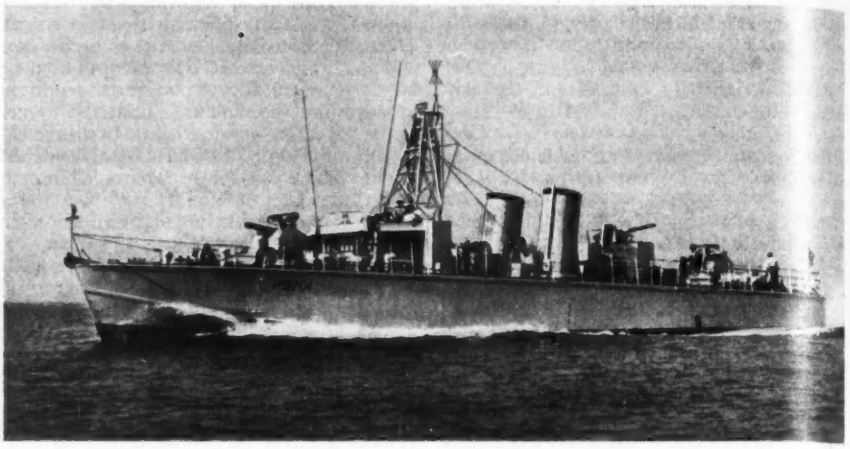


Fig. 4—New Fast Patrol Boat " Bold Pioneer "

Smaller Fighting Craft

The first three of a new design of fast patrol boats completed under the emergency programme ordered in 1951, the " Gay Archer," " Gay Bombardier " (Fig. 3), and " Gay Bowman," which cost £103,200 to £78,200 each, were accepted into H.M. service in February and March, 1953, from their builders, Vospers, Ltd., Portsmouth, which is the parent firm for this class of coastal forces craft. Some thirty-eight of these vessels, which are interchangeable as motor torpedo boats and motor gunboats, are now completed or in course of construction, but they are subdivided into two groups, twenty-one with the prefix " Gay," being almost entirely of wooden construction, the hulls incorporating structural members of water-resistant plywood, and seventeen with the prefix " Dark," which are of composite construction. They are " short " boats representing a development of the short M.T.B.s produced during the second world war. They have an overall length of 75ft 2in and a beam of 19ft 8in, and their main machinery consists of the usual petrol engines by Packard. The " Gay " class, as motor torpedo boats, are armed with two 21in torpedo tubes and two small guns, although, according to the 1953–54 Navy Estimates, the " Gay Centurion," built at the Hampton Launch Works of John I. Thornycroft and Co., Ltd., London, is armed with four 21in torpedo tubes and one small gun. In the gunboat role they carry a 4·5in gun and a smaller weapon. Here, again, several smaller boat-building firms were entrusted with the construction of the " Dark " and " Gay " class craft, although Vospers, Ltd., was selected by the Admiralty to act as the " parent " firm in which capacity it was responsible for producing the necessary working drawings for issue to a number of " daughter " firms. The parent firm was authorised, under the Admiralty, to progress the orders and give general advice and assistance to the " daughter " firms.

In addition to these craft of conventional M.T.B. or P.T.S. type, two experimental fast patrol boats were accepted into naval service in 1953, the " Bold Pathfinder," from the Portchester yard of Vosper, Ltd., and the " Bold Pioneer " (Fig. 4), from the Cowes yard of J. Samuel White and Co., Ltd. These " Bold " prototypes are convertible gunboats or torpedo boats, and are the first two craft of the motor torpedo boat category in the Royal Navy to be powered by gas turbines in combination with diesel engines. They are officially regarded largely as sister ships, though they are not identical in many respects, differing in hull form, dimensions and layout. Both craft are fitted with gas turbines made by the Metropolitan Vickers Electrical Company, Ltd., of Manchester, the main machinery installation having been undertaken in each case by the shipbuilder. The turbines were developed from the successful " Gatric " engine. The propelling plant in both vessels comprises two " G.2 " gas turbines, each of 4500 s.h.p. (aggregating 9000 s.h.p.), and two diesels, each of 2500 b.h.p. (aggregate 5000 b.h.p.). Each vessel is armed with two 4·5in guns and one 40mm Bofors A.A. weapon as a gunboat, or with four 21in torpedo tubes and a small gun as a torpedo boat. The principal dimensions of the craft and the details of machinery installations differ because of hull form and construction.

The " Bold Pioneer," which cost £292,000, is largely of timber construction with a hard chine hull form and twin funnels abreast

Fig. 3—" Gay Bombardier " as Torpedo Boat

each other of a section almost square at the base and round at the top. With an overall length of 121ft and a length between perpendiculars of 116ft 3in, she has a wide beam of 25ft 6in and a draught of 6ft 10in. The "Bold Pathfinder" (Plate 1) is largely of light alloy construction with a round bilge hull form and twin funnels abreast of a section approximately rectangular at the base drawn up into a streamlined pear shape. She has an overall length of 122ft 8in and a length between perpendiculars of 117ft with a beam of 20ft 5in and draws 6ft 7in of water. She cost £357,000.

The first of an entirely new design of vessel for the Royal Navy known as seaward defence boats, namely, the "Shalford," was accepted into H.M. service in 1953. Built by Yarrow and Co., Ltd., Scotstoun, the parent firm, at a cost of £154,600, with main machinery manufactured by Davey Paxman and Co., Ltd., Colchester, and Fodens, Ltd., Sandbach, Cheshire, she has an overall length of 117ft 3in and a length between perpendiculars of 110ft with a beam of 20ft. There are now eighteen of these specialised craft completed or under construction, all having place names with the suffix "ford." Powered with diesel engines, their purpose is to detect, locate and destroy submarines, including midget submarines, in the approaches to defended ports. Their armament includes guns, flares, and depth charges and they also carry electronic equipment. In appearance they are similar to the "Bold" fast patrol boats.

(To be continued)

British-built Locomotives of 1953

OUR review of interesting locomotives completed in this country during the past twelve months deals mainly with engines built by private manufacturers for overseas markets. This does not indicate by any means that the workshops of British Railways have not been fully occupied, for, in addition to turning out an appreciable number of other steam locomotives, the first of the new standard class "2" engines were completed and introduced into service. In connection with these standard locomotives, it is interesting to note that the production programme announced by British Railways in July last stated that 150 of the 288 locomotives it was proposed to build during the year would be of the new standard designs. A statement made by Mr. Gurney Braithwaite, the Parliamentary Secretary to the Ministry of Transport, during the debate on the annual report of the British Transport Commission in October last indicated, however, that the actual production of locomotives would probably fall short of the number laid down in the programme. It was stated that the difficulties caused by shortage of material and their effects on productive capacity in recent years continued to be felt in the organisation of railway workshops. Although the material position had eased, it was considered doubtful if the workshops would attain full potential production for some time to come.

The private locomotive manufacturing companies also continued to feel the effects of post-war shortages, particularly the shortage of steel plates, the restricted supply of which has been a prime cause in production delays in more recent times. During the past year there have been criticisms from overseas purchasers on the failure of manufacturers to keep to delivery promises. This inability of British makers to fulfil delivery within the time specified when quoting for orders is likely to have serious repercussions, in view of the increasing competition from foreign manufacturers. Now that British Railways no longer place appreciable orders with private works, the locomotive firms in this country are practically dependent upon overseas business, and it would be disastrous indeed if the handicaps imposed in recent years by material shortages are not quickly surmounted. In design and construction the British locomotive manufacturer is second to none and with the easing of the steel plate position now in evidence it is to be hoped that he will be in a better position to quote for reasonably short deliveries and keep to his commitments.

Before turning to some of the locomotives built in this country during the past year attention should be drawn to a paper of particular interest which was read before the Institution of Locomotive Engineers by Mr. A. W. J. Dymond in February last. This paper was entitled "Operating Experiences with Two Gas Turbine Locomotives," and it described the difficulties, disappointments and the successes experienced with the Brown Boveri and the Metropolitan-Vickers gas turbine locomotives now in service on the Western Region of British Railways. This new form of motive power for railways is being watched with keen interest, and Mr. Dymond's paper gave an interesting and graphic insight into the early problems which were experienced. Also of particular interest to all students of railways was the presidential address given by Mr. R. C. Bond to the Institution of Locomotive Engineers, in which he looked back over his thirty-three years' experience in the maintenance and construction of locomotives. In reviewing the "years of transition" as he called them, Mr. Bond dealt with the alternative forms of motive power and presented the case for each in a clear, objective survey.

Steam Locomotives

As already mentioned, the first of the new standard class "2" locomotives were introduced on British Railways during the year. Under this classification there were placed in service ten 2-6-0 tender and the first of twenty 2-6-2 tank engines.

The new engines are the smallest to be built in the projected range of twelve standard classes of locomotives for British Railways, and they incorporate many of the modern developments which have proved successful on the larger designs. In the engines soft grease lubrication is widely used with nipples arranged in readily accessible groups, and they have a rocking grate, a self-emptying ashpan and a self-cleaning smokebox. The new engines can be seen in photographs we reproduce here, and the leading dimensions common to both are as follows :—

Cylinders, number, diameter and stroke	Two 16½in by 24in stroke
Wheels, coupled, diameter	5ft
Wheelbase, coupled	13ft 9in
Heating surface :	
Tubes	924 square feet
Firebox	101 square feet
Total, evaporative	1025 square feet
Superheater	134 square feet
Grate area	17·5 square feet
Boiler pressure	200 lb per square inch
Tractive effort	18,513 lb

The tender engine weighs 49 tons 5 cwt in working order and has an adhesion factor of 4·9, and the tank engine, with a weight of 63 tons 5 cwt, has an adhesion factor of 4·7. Where possible, the boiler fittings are made to the same standards as other B.R. locomotives. The main steam manifold is placed on the top of the firebox outside the cab and on it are mounted all the separate shut-off cocks to each steam supply pipe, a main shut-off valve operated from inside the cab being also provided. A manually operated blowdown valve is fitted for the discharge of sludge from the front of the firebox.

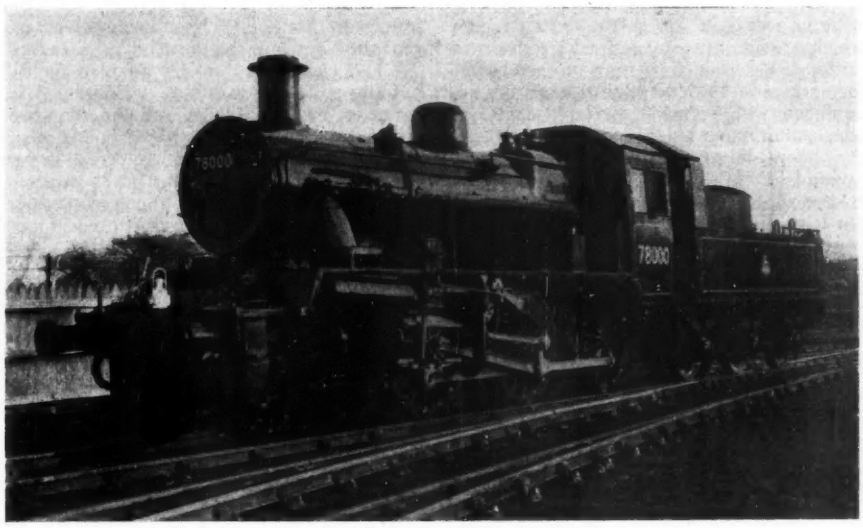


Fig. 1—2-6-0 Class "2" Locomotive

Steam distribution to the two outside cylinders is controlled by piston valves of 8in nominal diameter driven by an outside Walschaerts gear, giving a valve travel of approximately 6in with 1 5/16in steam lap and ¼in lead. These valves are lubricated by oil delivered through atomisers from the cylinder mechanical lubricator. The pins of the valve gear are grease lubricated, except the expansion link and radius rod die pins, dies and die paths, which are oil lubricated. The bearing of the return crank rod big end is of self-aligning ball design. By adopting steam operation of the cylinder drain cocks all shafts and rods as used with mechanical operation are eliminated.

Early in the year it was announced that,

after tests made with a locomotive fitted with cam poppet valve gear in 1949, five locomotives for the London Midland Region of British Railways were being fitted with this gear. The "R.R." cam poppet valve gear used was constructed to the designs of Mr. A. Reidinger and supplied by Locomotive Valve Gear, Ltd. Four of the five two-cylinder class "5MT" locomotives fitted with the gear have camshafts fitted with cams, which provide a predetermined steam distribution as ascertained by trials on the original locomotive of 1949. The fifth locomotive is equipped with vernier adjustable cams, by which alternative independent valve settings can be made so that their effects can be investigated in a two-cylinder locomotive. A description of the valve gear was given in our issue of February 27, 1953. All students of the steam locomotive will await with interest to hear the results of this larger-scale test of cam poppet valve gear in service.

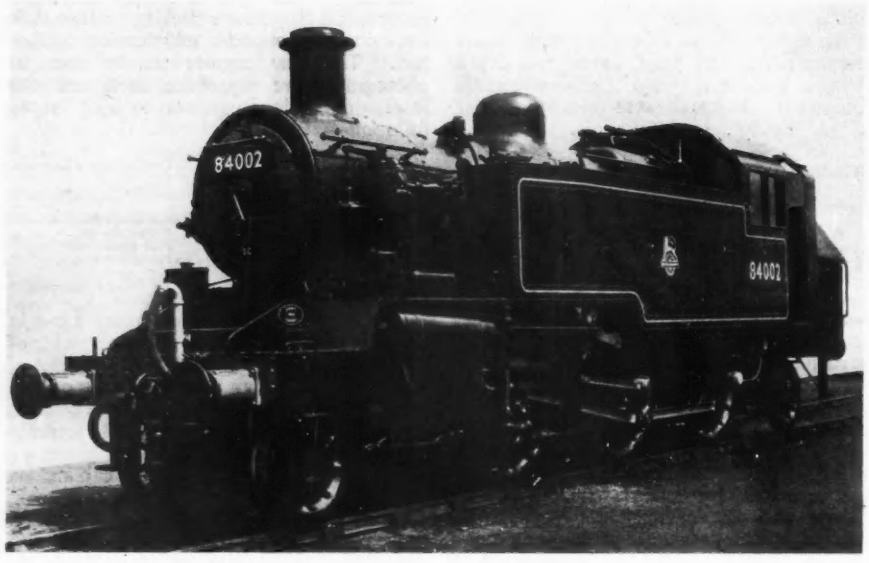


Fig. 2—Standard Class "2" Tank Engine

British-Built Locomotives for Overseas Railways

At the Newton-le-Willows works of the Vulcan Foundry, Ltd., there were completed a further ten "P.S.11" class 4-6-2, three-cylinder locomotives for the Argentine Railways; these engines were similar in their main characteristics to twenty built in 1950. In our annual review last year we gave details of the 2-10-2 locomotives this company was building for the Iranian State Railway. Sixty-four of these engines were ordered and during 1953 thirty-nine were delivered to complete the order.

One of ten metre-gauge 2-8-2 oil-burning locomotives built by the Vulcan Foundry, Ltd., last year for the Iraq Railway is illustrated on Plate 7. These locomotives are generally similar to the Indian standard "Y.D." class, but they are adapted for oil burning. They have two cylinders, 17in diameter by 24in stroke and 8in diameter piston valves actuated by Walschaerts gear. With a boiler working pressure of 180 lb per square inch the tractive effort at 85 per cent boiler pressure is 22,110 lb. Each locomotive in full working order weighs just over 56 tons and the tender just over 40 tons.

Amongst the locomotives constructed at the works of Beyer, Peacock and Co., Ltd., were a number of 2-6-2+2-6-2 "14A" class and 2-8-2+2-8-2 "16A" class engines for the Rhodesia Railways. Some of the eighteen "14A" class ordered have already been placed in service and the others are being delivered. These engines, one of which can be seen on Plate 7, are a completely modernised version of sixteen 2-6-2+2-6-2 engines which were delivered by the company in 1925 and 1929 and have proved particularly successful in service.

In the new engines the Walschaerts valve gear has been redesigned, and they are fitted with Hadfield power reverse gear and self-adjusting pivots. All of the carrying wheels have Timken roller bearing axleboxes. The leading particulars of the redesigned locomotives are as follows:—

Cylinders, number, diameter and stroke	Four, 16in by 24in
Coupled wheels, diameter	4ft
Axle load	13·5 tons
Coal capacity	7 tons
Water capacity	3600 gallons
Boiler pressure	180 lb per square inch
Total heating surface	2215 square feet
Grate area	38·6 square feet
Tractive effort at 85 per cent. B.P.	39,170 lb
Total weight in working order	132 tons

The class "16A" locomotives, of which thirty have been built, are of a class originally introduced on the Rhodesia Railways more than twenty years ago. The new locomotives now incorporate modern developments, which enable them to give a considerably improved performance. In full working order they each weigh 167 tons and at 85 per cent boiler pressure have a tractive effort of 55,270 lb.

These locomotives, one of which can be seen in the illustration below (Fig. 3), have boilers and many other parts which are interchangeable with the "15th" class locomotives recently introduced on the railway. They have engine unit frames of bar design, machined from rolled steel slabs and self-adjusting oil bath pivot centres cast integrally with the frame stretchers incorporate spring-loaded side bearers, and the pivots are mechanically lubricated. The 18½in diameter by 24in stroke cylinders have 9in diameter piston valves, actuated by Walschaerts gear with a travel of 6in.

The coupled wheels and axles are generally in accordance with the "15th" class engines, and the whole of the revolving parts and 26 per cent of the reciprocating parts are balanced to limit the hammer blow to 1 ton when running at 40 m.p.h. A number of changes have been made in the design of the bogie details, and the axlebox housing has been arranged for easy conversion from plain to roller bearings. Twenty of the new locomotives have been fitted with plain bearing axleboxes and ten with Timken roller bearing axleboxes.

A photograph reproduced on Plate 7 shows a class "WM" 2-6-4 tank locomotive built for the Indian Railways by Robert Stephenson and Hawthorns, Ltd. An order for thirty of these engines has been placed with the company and they are now being delivered at the rate of one a week. These engines are for the 5ft 6in gauge and have cylinders 16in diameter by 28in stroke, the

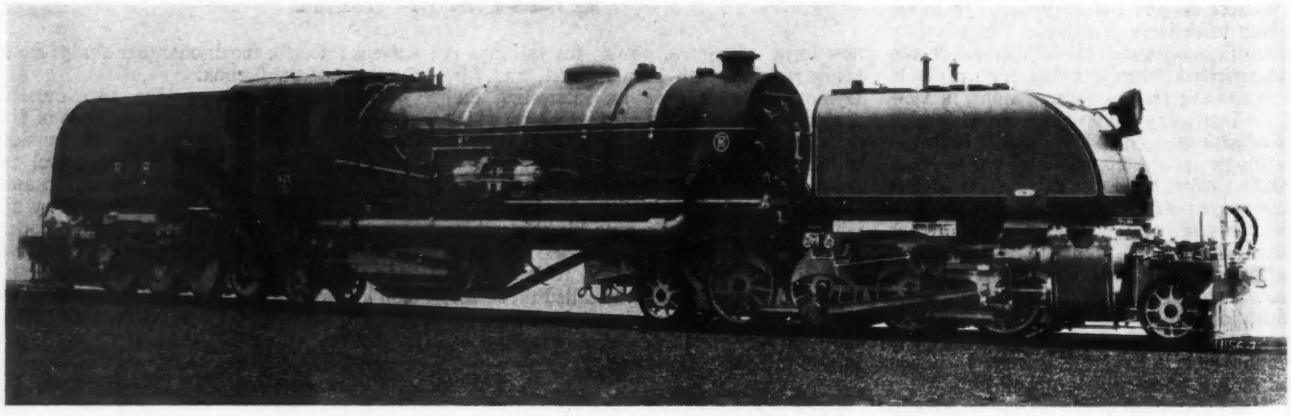


Fig. 3—2-8-2+2-8-2 Locomotive for the Rhodesia Railways

working pressure being 210 lb per square inch. In full working order each engine weighs just over 97 tons and the tractive effort at 85 per cent boiler pressure is 19,084 lb, the factor of adhesion being 5·7. The same company also completed during the year an order for ten "YL" class engines for the Indian Railways.

The Yorkshire Engine Company, Ltd., supplied a 2-6-0 standard-gauge locomotive to the Paraguay Central Railway. This locomotive is designed to burn wood fuel, and with its adhesive weight of 42·5 tons has a tractive effort of 21,400 lb at 75 per cent boiler pressure.

We are informed by W. G. Bagnall, Ltd., that all departments of its Castle Engine Works were fully employed last year on the production of steam, fireless and diesel locomotives. A further batch of ten 0-6-0 shunting locomotives completed for the Western Region of British Railways formed part of a very large order placed by the former Great Western Railway and ten more are now under construction to complete the order. Other locomotives built for the home market include an 0-4-0 shunter for use in a Cornish clay pit, a fireless locomotive for shunting in the coal yard of the new Huncoat power station of the British Electricity Authority, and several 0-6-0 shunters with 16in cylinders for the National Coal Board.

In Fig. 4 we illustrate one of three articulated 0-4-0 steam shunting engines built by this company. Two of these locomotives, built for 2ft gauge, were supplied to Sir J. L. Hulett and Sons for use on sugar estate railways in Natal, and the third was ordered by Bowater Lloyd Pulp and Paper Mills, Ltd., for use on 2ft 6in gauge lines in Kent. Apart from the rail gauge the three locomotives are identical. The steam is carried from the boiler to the power bogies by steel pipes with "Flextel" joints and similar pipes lead the exhaust from the cylinders to the blast pipe. The working pressure is 185 lb per square inch and the tractive effort at 85 per cent is 12,737 lb.

Diesel Locomotives

In connection with the use of diesel locomotives in service in this country, an event of particular interest last year was the publication by the Railway Executive of a bulletin dealing with tests of a main line diesel-electric locomotive on the Southern Region. The locomotive tested was one of those which was built for the late Southern Railway Company and described in our issue of February 9, 1951.

The trials were conducted in two groups: first, observational tests on revenue-earning trains were made to obtain average performance and efficiency values in representative service; secondly, there were made a series of analytical tests, to obtain the basic fuel consumption related to the drawbar tractive effort and horsepower, in some way analogous to the obtaining of the characteristic curves of the steam locomotive performance by tests on the stationary plant, and by controlled road tests at constant evaporation. Full details of the trials were given in an article by Mr. O. S. Nock in THE ENGINEER of October 2nd last.

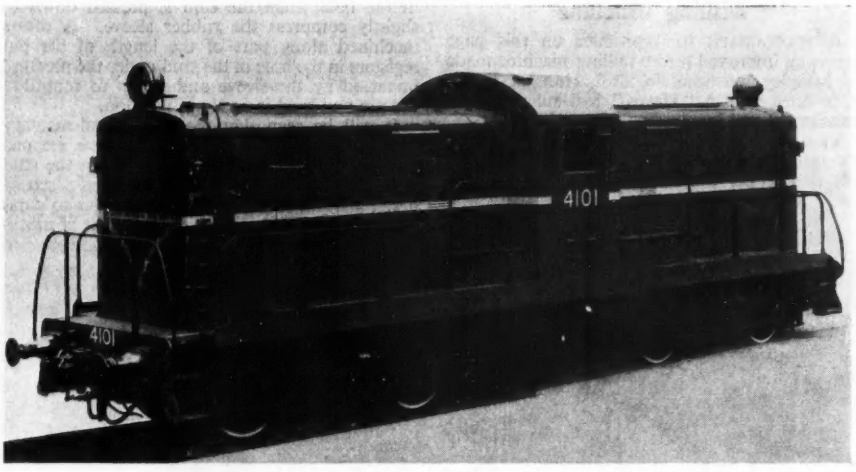


Fig. 5—1000 H.P. Diesel-Electric Locomotive

British Railways issued particulars in June last of the standard diesel-electric shunting locomotives which had been placed on order. The general layout of these locomotives follows closely the design of the more recent regional diesel-electric shunters fitted with nose-suspended motors and double reduction gears. Certain modifications were made to suit operating requirements, and give the locomotives the widest possible route availability. Provision was also made for using the engines and electrical equipment of a number of manufacturers with a minimum amount of alteration to the main locomotive structure. The locomotives have an 0-6-0 arrangement, weigh 49 tons in full working order and have a maximum speed of 20 m.p.h.

Ten 1000 h.p. diesel-electric locomotives were completed for the New South Wales Government Railways under an order placed with the British Thomson-Houston Company, Ltd. The mechanical parts of these locomotives were supplied by the Metropolitan-Cammell Carriage and Wagon Company, Ltd., and the engines by Davey, Paxman and Co., Ltd. As can be seen from the photograph reproduced in Fig. 5, these locomotives are B_0-B_0 equipments; they each weigh some 80 tons in full working order.

These locomotives are particularly intended for shunting and hauling heavy freight trains. They have a maximum tractive effort of 51,000 lb at starting, 22,800 lb continuously and 29,000 lb at the one-hour rating. With a maximum permissible road speed of 57 m.p.h. the locomotives can be used for hauling passenger and mixed-traffic trains. Two separate 500 h.p. engine-generator sets are fitted, so that, at times of light running only one set need be used to give economy in operating. The driving cab is arranged centrally and dual controls are provided to enable the driver to operate from either side of the cab.

The British Thomson-Houston Company, Ltd., also acted as the main contractor for an order for eighteen 400 h.p., 3ft 6in gauge, diesel-electric shunters for the Western Australian Government Railways. Four of the locomotives were shipped during the year under review, and they are the first diesel-electrics to be used by the Western Australian Government Railways. These B_0-B_0 locomotives each weigh some 40 tons and with their maximum speed of 40 m.p.h. they are suitable for hauling light passenger trains as well as for shunting duties. Their mechanical parts were supplied by the Clayton Equipment Company, Ltd., and the engines by Davey, Paxman and Co., Ltd.

Amongst the diesel mechanical locomotives delivered by the Hunslet Engine Company were a 500 h.p., 0-6-0, standard-gauge locomotive; two 0-4-0, 300 h.p. locomotives for the works of the Consett Iron Company, Ltd.; and four 0-8-0 locomotives for the Sudan Gezira Board. These locomotives for the Sudan are used on 60mm gauge and have a McLaren 120 h.p. engine driving through a constant-mesh gearbox, giving four speeds of 5, 8·75, 14·6 and 20 m.p.h. They operate under somewhat unfavourable conditions in a dirty atmosphere in temperatures up to 120 deg. Fah. and up to 1200ft above sea level.

The North British Locomotive Company, Ltd., completed two diesel-hydraulic locomotives for the Mauritius Railway, and details of these locomotives were given in our issue of November 20th last. They are each powered by a Paxman engine with a twelve-hour rating of 625 h.p. at 1250 r.p.m., and the drive is transmitted through a Voith-North British hydraulic unit with a two-speed final drive. In the low-speed range each locomotive has a maximum tractive effort of 35,800 lb and in the high-speed range 23,000 lb, the respective maximum speeds being 25 and 45 m.p.h.

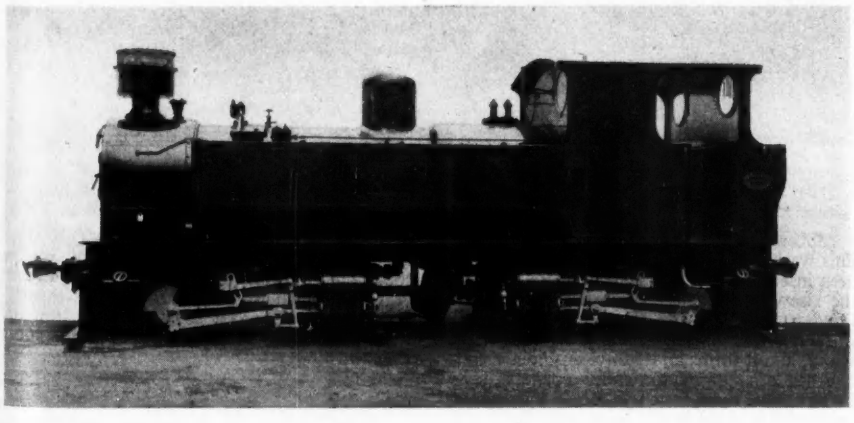
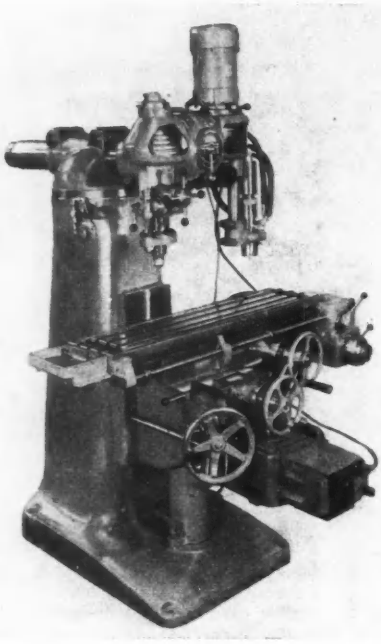


Fig. 4—Articulated Steam Shunting Locomotive

Milling Machine

A PHOTOGRAPH we reproduce on this page shows an improved turret milling machine made by Midgley and Sutcliffe, Ltd., Hunslet, Leeds. It is fitted with a "Hayes" hydraulic copying attachment and longitudinal power feed.

This machine has a 33in by 9in table with six rates of longitudinal power traverse from ½in to 12in per minute, a hand-operated cross



Turret Milling Machine

traverse of 9in, and a hand-operated vertical traverse of 14in. Its turret is clamped on the column by four bolts and can be rotated through a full circle. The turret bar on which the head is mounted is slidable in the turret and clamped in position by two pad bolts. The head is one of the firm's standard "Hyspeedmil" units which can be rotated through 360 deg. on the bar. This head is driven through back gears and multi-step vee pulleys by a ¾ h.p. motor and has a range of spindle speeds from 130 to 4100 r.p.m. If required, the head can be removed and replaced by a slotting attachment with a fixed stroke of 2in.

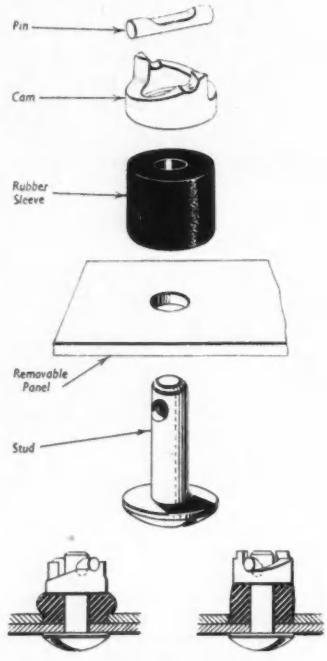
The head spindle has a vertical adjustment of 3½in and when the tracer unit mounted at the side of the head is in operation it controls the spindle movements by hydraulic means. When it is required to arrange the machine for a fully automatic cycle it can be arranged for a reciprocating table feed and a cross traverse pick feed.

Quick-Action Fastener

A QUICK-ACTION fastener has been developed by Silentbloc, Ltd., Victoria Gardens, Ladbroke Road, London, W.11, for use with removable panels, such as are fitted on instrument panels or on special bases. Panels equipped with these "Vibrex" fasteners can be quickly and easily fixed in place or removed without the use of special tools. Each fastener is so constructed that it serves to absorb vibration and keep out dust or moisture. The component parts of a fastener and its method of attachment can clearly be seen in the drawings reproduced herewith.

To fit the fastener a 7/32in diameter hole is drilled in the removable panel, and a complementary ¼in diameter hole is drilled into the face or brackets of the cabinet, to which the panel is to be attached. Into the panel hole there is inserted the fastener stud, which has a slotted head and a pinhole drilled near the end of its shank. A rubber sleeve and a profiled metal bush, known as the cam, are then placed on the stud shank. With the hole in the stud in line with the deepest recess in the cam a retaining pin can be inserted in the hole when the cam is pressed down to slightly compress the rubber sleeve. A recess machined along part of the length of the pin registers in the hole in the stud under the pressure imparted by the sleeve and serves to centralise the pin and hold it firmly in position.

It will be seen that the two complementary profiles in the sides of the cam have stepped recesses near their upper parts. When the stud is turned through 180 deg. by means of a screwdriver the pin rides up the cam profiles to compress the rubber sleeve, and at the limit of movement the pin slips over into the stepped recess to



Details of Quick-Action Fastener

lock firmly. During this operation the rubber sleeve is compressed lengthwise and is deformed as shown in the lower left-hand drawing. The sleeve expands outwards to impart a strong frictional grip on the hole in the cabinet and to form a substantial head over the hole at the rear of the cabinet wall.

If it is required to eliminate metal-to-metal contact between the panel and a cabinet or base a rubber cushion washer can be introduced. This washer is slipped over the stud after it has been inserted in the removable panel and before the sleeve is applied. When the panel is then fitted to the base and the stud is turned, the washer is compressed at the same time as the sleeve, and it forms an effective cushion.

When it is required to remove a panel attached by means of these fasteners a half turn of each stud quickly releases the hold, and there is no risk of loose nuts, bolts, screws or washers falling off as the panel is lifted out.

Railway Coach Construction

WE recently visited the works of Charles Roberts and Co., Ltd., at Horbury Junction, Wakefield, to inspect the first railway coach to be built by this company, which has for nearly a hundred years specialised in the design and construction of railway wagons for all purposes. The coach was one of an order placed with the firm by British Railways for forty-four standard design, all-steel, type "E," corridor, third-class and brake vehicles.

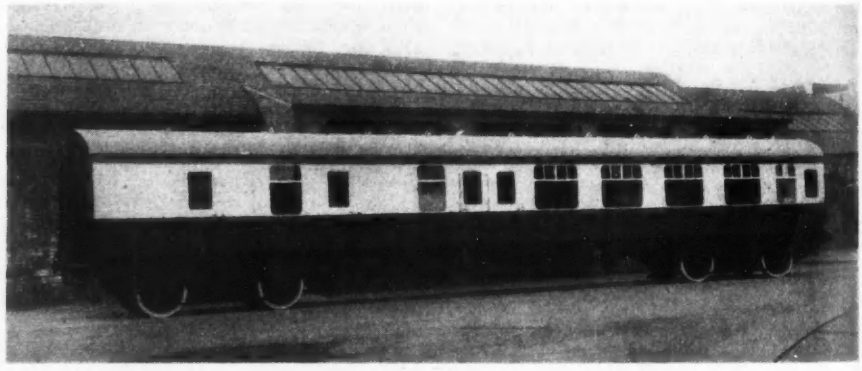
Although the manufacture of steel coaching stock for railways is a new departure for the firm it has at its disposal many years' experience of steel rolling stock construction as it was one of the first firms to make all-steel wagons. In order to build the coaches the company has laid down a new line in its main shops, and equipped it with welding and erection fixtures and jigs. This new line has made possible the production of the coaches to the limits and standards called for by British Railways and it can be readily adapted for future work of the same kind.

One of the standard corridor third brake coaches being made by Charles Roberts and Co., Ltd., is illustrated on this page. It is 66ft 5in long over the gangways and weighs some 34 tons. Its body, fabricated from pressed steel members, is mounted on an underframe of welded rolled steel sections. The four-wheeled, double-bolster bogies are set at 46ft 6in centres and each has a wheelbase of 8ft 6in.

The principal body members are of "top hat" section and the body side is a continuous radius from the floor to the cant rail. To enable flat glass windows to be fitted, the outer steel panels are pressed flat round the window openings. The ends of the body are of particularly strong construction to offer resistance to crushing in case of accidents. A roof of galvanised steel sheets is carried on pressed steel carlines. The coach body is divided to provide a luggage compartment 22ft 8in long by 6ft 3in wide, a 6ft 9in by 5ft 10in guard's compartment, a centre vestibule, four third-class compartments each seating six passengers, a lavatory and an end vestibule.

The electrical gear carried on the underframe includes two groups of batteries, a dynamo driven from the bogie axle, a regulator, a controller, a distribution fuse-box, charging sockets and emergency lighting points. Automatic Buckeye couplers are fitted, together with screw couplings which enables the coaches to be coupled to existing rolling stock.

After we had inspected the coach we were shown a selection of the other rolling stock under construction at the works. This stock included an all-steel, 16-ton mineral wagon, some 2000 of which are being turned out each year for British Railways; a 16 tons capacity hopper coal wagon, a 25-ton hopper iron ore wagon, tank wagons, and all-steel covered goods wagons.



Standard All-Steel Type "E" Railway Coach

RARER BASE METALS.—A special course on the rarer base metals and their production and industrial applications is to be held at the Acton Technical College during the coming spring term.

Industrial and Labour Notes

Engineering Wages

On Wednesday of last week, December 23rd, the executives of the thirty-nine unions comprising the Confederation of Shipbuilding and Engineering Unions met in London to consider their next move in the engineering and shipbuilding wages dispute. The dispute has arisen because of the rejection of a claim for an all-round wage increase of 15 per cent.

The delegates at last week's meeting carried a resolution which was formulated by the confederation's executive council. This resolution expressed appreciation of the "demonstration of loyalty and solidarity" when engineering and shipbuilding workers engaged in a twenty-four-hour strike on December 2nd. It went on to propose that all unions affiliated to the confederation should instruct their members engaged by firms in the employers' federations to ban overtime and restrict piecework as from January 18th. This means that no more than forty-four hours a week, whether on day, night or other shift systems, would be worked, and that payment-by-results workers would limit their output to the equivalent of a forty-four-hour week.

After the conference on December 23rd, the chairman and general secretary of the Confederation of Shipbuilding and Engineering Unions saw the Minister of Labour, Sir Walter Monckton. Sir Walter also saw, on the same day, representatives of the Engineering and Allied Employers' National Federation. As we go to press with these notes, further talks between the Minister of Labour and the employers' and union representatives are in progress.

Britain's Overseas Trade

Exports of United Kingdom goods in November were valued at £239,900,000, according to the final figures published by the Board of Trade just before Christmas. As there were only twenty-five working days in November, the daily rate of export was higher than in any preceding month last year.

The Board of Trade says that, for the period July to November, exports averaged £220,400,000 a month, or 9 per cent more than in the corresponding five months of 1952, but 3 per cent less than in the first half of 1952. With the increase in exports in October and November, the value of United Kingdom goods exported in the first eleven months of last year was within 1 per cent of the total for the corresponding period of 1952. There has been some decline in export prices, and the Board of Trade has estimated that, in the first eleven months of last year, the volume of exports was about 3 per cent greater than in the corresponding period of 1952. Imports in November, which were valued at £272,200,000, continued at about the same rate as in recent months. For the first eleven months of 1953 the average monthly value of imports was £278,800,000, compared with £292,600,000 over the corresponding period of 1952. This 5 per cent decline, the Board of Trade comments, was a consequence of a considerable fall in prices up to the middle of 1953; the volume of imports in the first eleven months of last year has been estimated as about 10 per cent more than in the comparable period of 1952. With re-exports averaging £8,900,000 a month, the excess of imports over total exports during January to November last averaged £55,500,000 a month, against £64,400,000 in the corresponding period of 1952.

The increase in exports in the two months October and November, compared with the third quarter of last year, was shared by nearly all groups of commodities. The Board of Trade figures reveal that exports of engineering products increased by 10 per cent, although a large part of that increase represented a recovery from the low figures recorded for the third quarter. For the five months, July to November, the monthly average of exports of engineering products was slightly less than in the first half of last year and was still 3 per cent below the average monthly rate for 1952. The level of exports of electrical goods and machinery was lower in the five-month period, July to November last, than in the first half-year, but vehicle exports were a little higher, mainly because aircraft exports reached a record level. Exports of raw materials in October and November were worth £2,000,000 a month more than in the third quarter, mainly as a result of more shipments of coal.

About the pattern of trade, the Board of Trade says that, from provisional estimates, it seems that exports to the sterling area in October and November were about 13 per cent more than in the third quarter. Those to the non-sterling area were about 8 per cent higher.

Industrial Production

In its review of the general economic situation, the Treasury has stated that last year the output of British industry was undoubtedly higher than in 1952. Whilst, of course, figures for the whole of the year are not yet complete, the Treasury has estimated that the index of industrial production (1948=100) for 1953 may turn out to be 118 for all industries, compared with 113 for 1952 and 117 for 1951. The last quarter usually tends to bring the average up a point or two. In 1951, however, the recession was beginning to show in the closing months, but towards the end of 1953 the normal tendency appeared to be operating.

Giving some industrial "indicators," the Treasury points out that deep-mined coal output in September and October last—after making allowance for longer holidays—was the same as in 1952; in November it was nearly 2 per cent higher than a year earlier. Industrial coal consumption in September and October was 2 per cent higher than in the corresponding months of 1952, but the weather in those months of 1952 was exceptionally cold, and if adjustment is made for that factor it would seem that the level of industrial demand for coal in the latter part of 1953 was about 6 per cent higher than in 1952. Crude steel production in November, 1953, was an all-time record, and deliveries of finished steel were running at about 7 per cent above the 1952 level. In the manufacturing industries, motor-car output in September and October last was 38 per cent above the average for those two months of 1952. Some classes of industrial plant and equipment were showing higher output figures towards the end of last year, compared with 1952, but others were falling. The value of factory buildings under construction at the end of last September was higher than it had been for two years, although it was 14 per cent below the September, 1951, figure.

But, the Treasury has emphasised, most of last year's rise in production derived from an increase in home demand, including some restocking, and not from higher exports. Whether production can be maintained and pushed to new heights in 1954 will depend to some extent on whether the trend of exports can be directed sharply upwards again.

Coal Production

In the last full week prior to the Christmas holiday, the total coal output amounted to 5,002,900 tons, the biggest quantity produced in a single week in this country since 1938. This total was made up of 4,772,200 tons from the deep mines and 230,700 tons from opencast workings. In the comparable week of 1952, the total quantity of coal produced was 4,614,000 tons. The National Coal Board has stated that since the beginning of the winter, coal production has increased. Since early November consumption has been lower than in the comparable period of 1952, but production at the pits has gone up by more than 850,000 tons.

Figures issued by the Ministry of Fuel and Power show that in fifty weeks of 1953, ended December 19th, coal production totalled 216,915,600 tons, compared with 218,601,400 tons in the corresponding period of 1952. The amount from opencast workings was much the same in both years, but deep-mined production up to December 19, 1953, was at 205,539,700 tons, about 1,200,000 tons less than the 1952 figure for the comparable period. The deep-mined tonnage lost last year through disputes was lower than in 1952, but the additional holidays granted to mineworkers meant that the loss through recognised holidays in 1953 was 12,811,900 tons, compared with 7,416,300 tons in 1952. The number of workers on colliery books on December 12th last was 709,300, of whom 299,200 were face workers. A year earlier, the total manpower was 719,700, of whom 298,500 were working at the face. Distributed coal stocks on December 12th totalled 19,079,000 tons, compared with 17,946,000 tons a year earlier.

Production Costs

Speaking in Birmingham on December 23rd, Mr. H. E. Jackson, president of the British Non-Ferrous Metals Federation, described the latest industrial production figures as heartening, but said that British industry still had to fight the "battle of hours" in export markets. That, he commented, was the battle between the six-day German and Italian working weeks and the five-day week in this country. Mr. Jackson added that he believed present difficulties would be overcome, but he also deplored the fact that manufacturing costs continued to rise, thereby forcing prices still higher. A rise in wages without greater productivity would inevitably mean increased charges all round and higher selling prices. He agreed that improved productivity was in a large measure the responsibility of managements, but to achieve it called also for the participation of unions and workers.

Some comments on costs were also made last week by Sir Harold Bowden in his chairman's address at the annual meeting of Raleigh Industries, Ltd. He spoke in particular of the cycle manufacturing industry, saying that there were certain signs of a stabilisation in the cost of materials. But, Sir Harold observed, labour costs had shown a continued rise since the end of the war, and if the industry which he represented was to maintain its present hold upon the world's markets a halt must be called to further wage increases, which did not bring increased production in their train. With foreign manufacturers knocking at the doors of this country's export markets it was essential that our prices should be truly competitive and costs kept to the minimum.

O.E.E.C. Report on Britain's Economy

The Organisation for European Economic Co-operation has published a report surveying the United Kingdom's economic situation. The figures given in the report do not, in general, go beyond the third quarter of last year, but one conclusion drawn from them is that the rise in industrial production in Britain since 1950 has lagged behind that of other O.E.E.C. countries. With an index figure of 100 for 1950, the report shows that industrial production in this country in the second quarter of last year was 105, compared with 119 for other member countries, excluding Germany; 128 for other member countries, including Germany, and 129 for the U.S.A.

The report comments on the small proportion of additional resources devoted to industrial investment during 1953. It says that "a low ratio of national income devoted to industrial fixed investment places any country at a disadvantage relative to others in maintaining or increasing its competitive position in world trade." Such a disadvantage, the report adds, weighs heavily upon the United Kingdom, where the rise in output depends almost exclusively on improved productivity.

Notes and Memoranda

Air and Water

RETIREMENT OF CUNARD COMMODORE.—Captain H. Grattidge, O.B.E., the Master of the liner "Queen Elizabeth," and who succeeded Commodore Cove, in 1952, as Commodore of the Cunard fleet, has retired after completing forty-seven years at sea.

LLOYD'S WRECK RETURNS.—Lloyd's Register of Shipping has issued its returns of merchant ships totally lost, broken up, &c., for the quarter ended June 30, 1953. Of the steamships and motorships totally lost consequent upon casualty six ships of 17,623 tons gross were owned in Great Britain and Northern Ireland and seven ships of 5451 tons gross by the Commonwealth countries out of a world total of forty-nine ships of 64,864 tons gross. The world total of ships lost not consequent upon casualty amounted to eighty ships of 240,062 tons and of this total thirty-five ships of 113,724 tons were owned in Great Britain and Northern Ireland and six ships of 12,553 tons by the Commonwealth countries.

Miscellanea

LEIPZIG TRADE FAIR.—The next Leipzig Trade Fair will be held from September 5 to 15, 1954, and we are informed that the covered stand area has been increased for the event to some 160,000 square metres.

ADMINISTRATIVE STAFF IN SWEDISH INDUSTRY.—A survey which has been made recently in Sweden has revealed that in the last twenty years or so the number of administrative staff in industrial concerns has nearly doubled. In 1930 the total was 426,000, which figure had increased to 835,000 by 1950. In the same period the number of operatives employed decreased from 1,900,000 to 1,700,000.

TELEVISION TRANSMITTING STATION IN ISLE OF MAN.—Good progress has been made with the construction of the B.B.C.'s low power television transmitting station near Douglas, I.O.M., and the temporary station came into service on December 20th. This station operates on Channel 5, with frequencies of 66·75Mc/s for vision and 63·25Mc/s for sound, the transmissions being vertically polarised.

FULLY IMPREGNATED NON-DRAINING CABLES.—We learn that W. T. Henley's Telegraph Works Company, Ltd., 51–53, Hatton Garden, London, E.C.1, is manufacturing fully impregnated non-draining cables which, although primarily intended for vertical runs and similar situations, are also suitable for normal industrial use. Henley "F.I.N.D." cables are available for standard voltages up to and including 11kV.

COURSES IN HIGHER TECHNOLOGY.—The Regional Advisory Council for Higher Technological Education in London has issued a booklet giving details of special courses during 1954 and 1955 at technical colleges in London and the home counties. The courses are, for the most part, those which do not regularly appear in college calendars or prospectuses as part of the normal curriculum. Copies of the booklet, price 1s. 6d. each, are available from the Regional Advisory Council, Tavistock House South, Tavistock Square, London, W.C.1.

LINCOLN AND MEXBOROUGH POWER STATIONS.—The British Electricity Authority has received the consent of the Minister of Fuel and Power to the extension of the Lincoln and Mexborough power stations.—Two 20MW turbo-alternators and four boilers, each having an evaporative capacity of 120,000 lb of steam an hour, will be installed at Lincoln, bringing the installed capacity of the station up to 86MW. At Mexborough the new installation will consist of two 30MW turbo-alternators and three boilers, each having an evaporative capacity of 180,000 lb of steam an hour, increasing that station's installed capacity to 120MW.

I.E.E. BENEVOLENT FUND.—The president of the Institution of Electrical Engineers, Mr. H. Bishop, has made an appeal for contributions to the Institution's benevolent fund. This appeal states that last year the fund paid out £280 more than it received in subscriptions and donations, and that the present average contribution per member, 6s. 4d., is disappointingly low. Referring to "The Chesters" Estate (which was given to the Institution in 1944 by a member, as a memorial to members who lost their lives in the war), the appeal says that sixteen houses have been built and occupied, but that, to complete the development of the estate, about £35,000 is still wanted.

IMPROVEMENT IN B.B.C. HOME SERVICE COVERAGE.—As part of its plan to make local improvements in the coverage of the Home Service the B.B.C. has built a new low-power transmitting station at Hempstead, near Cromer. The new station came into service on Sunday, December 20th, and has a power of 2kW. For technical reasons it must use the same wavelength as the Northern Home Service, 434m (692kc/s) and, therefore, carries that programme. The station has been provided with a directional aerial system designed to give a good service in Sheringham, Cromer, North Walsham and Aylsham, without affecting reception of the Moorside Edge transmissions in north-west Norfolk and along the Lincolnshire coast.

RAILWAY MATERIALS HANDBOOK.—The United Steel Companies, Ltd., has just published a new handbook of nearly 400 pages dealing with the products of interest to railway engineers and stores superintendents which are made by its branch companies. In the main this book deals with the products of Steel, Peech and Tozer, and the Workington Iron and Steel Company. Its various sections deal in detail with the wide range of types and sizes of wheels, tyres, axles, springs, forgings, rails, sleepers and fishplates, as well as a number of other products made by the firms and used by railway undertakings. Each section dealing with a particular product also includes a brief description of the manufacturing process and these descriptions are supplemented by some excellent illustrations. Appendices at the end of the book give useful metallurgical notes, extracts from appropriate British Standards, and a collection of standard reference tables and data of use to engineers and designers.

THE INSTITUTION OF PRODUCTION ENGINEERS.—In last week's issue we reproduced an abstract from the paper read by S. P. Woodley, Superintendent, Supermarine Division, Vickers-Armstrongs, Ltd., in the session having as its theme the "Production Problems Arising from the Trend of Design," at the recent conference arranged by the Institution of Production Engineers. This abstract was erroneously attributed to G. H. Dowty. The paper by Mr. Dowty, Chairman and Managing Director, Dowty Equipment, Ltd., which discussed the special problems in the production of undercarriages, hydraulic equipment and fuel pumps, &c., was read, due to his absence through ill health, by Sir Roy Fedden.

AN OXIDATION CONFERENCE.—A joint conference between the Institution of Chemical Engineers, the Chemical Engineering Group of the Society of Chemical Industry, the "Koninklijk Instituut van Ingenieurs" (Royal Institution of Engineers) (Chemical Engineering Group), and the "Koninklijke Nederlandse Chemische Vereniging" (Royal Netherlands Chemical Society) (Section for Chemical Technology) on Unit Processes of Oxidation will be held in the Netherlands in 1954. This conference will take place at the Hague on May 6 and 7, 1954, and, in view of the necessity to limit the subject, the unit processes of oxidation have been chosen, while particular stress is being laid on the chemical engineering aspects of these processes.

NEW "CLEVELAND" AUTOMATICS.—The Selson Machine Tool Company, Ltd., the distributors of "Cleveland" automatics in the United Kingdom, announces that three additions have been made to the "Cleveland" range of single-spindle machines. The first of these machines is the 4¼in "Dialmatic," model "AB," a larger design of the well-known 2¼in and 3in machines, which is simple to set up and is suitable for short-run work. The two other new single-spindle automatics are known as model "AW" "Clevelands," and differ from the "AB" machines in that the variable forward and return turret feeds are obtained through automatic settings of an improved and simplified mechanical drive. With capacities of 2¼in and 4¼in, these two new machines are intended for use on general-purpose, high-speed production work.

BRAZING OF ALUMINIUM ALLOYS.—We have received from the Imperial Chemical Industries, Ltd., a booklet entitled "'Kynal' Aluminium Alloys and Fluxes for Brazing." In the booklet are listed the company's wrought and cast aluminium alloys suitable for brazing together with tables giving particulars of the filler alloys and brazing fluxes. The design of assemblies is discussed and typical joints illustrated, together with some notes upon the preparation and cleaning of parts before brazing. Sections of the booklet deal with torch, furnace, flux dip brazing and the brazing of castings, while cleaning after brazing is touched upon. The properties of brazed structures are discussed and also the surface finish of brazed parts, and there are tables which give information about cleaning solutions for assemblies and the pretreatment of brazed assemblies prior to painting.

Contracts

THE BRIGHTSIDE FOUNDRY AND ENGINEERING COMPANY, Ltd., Sheffield, has received a contract from the Karabuk Steel Works, Karabuk, Turkey, for a blooming and slabbing mill. The value of the contract exceeds £500,000.

RUSTON AND HORNSBY, Ltd., has received an order for eight gas turbines, each of 905 b.h.p., from the London County Council, to supply the power for the Northern Outfall Purification Plant at Beckton. Five of the turbines will drive blowers giving a constant flow of 100,000 cubic feet of air per minute and the remaining three sets will drive generators to provide the electrical power required by the station. All the gas turbines will use sewage gas as fuel and the value of the contract, which is expected to be completed by 1957, amounts to £635,000.

METROPOLITAN-VICKERS ELECTRICAL EXPORT COMPANY, Ltd., has received a contract worth more than 1,500,000 dollars (£530,000) from the Calgary Power Company, Canada. The contract covers the supply of a 66MW, 3600 r.p.m. steam turbo-generator set, which is the largest ever ordered for Canada. The set, which will be manufactured in the company's works at Trafford Park, Manchester, will consist of a two-cylinder turbine operating with inlet steam conditions of 1250 lb per square inch, 950 deg. Fah., and driving a 13·8kV hydrogen-cooled alternator. It will form the first generating unit in a new power station to be built by the Calgary Power Company at Wabamun, near Edmonton, in the province of Alberta.

A CONTRACT for the manufacture and installation of two large water wheel generators has been awarded to the English Electric Export and Trading Company, Ltd., by the United States Army Corps of Engineers at a cost of 3,651,476 dollars, which was the lowest bid received (approximately £1,300,000). The maximum output of each generator will be 84,740kVA at 13·8kV, 60 cycles, 85·7 r.p.m. (approximately 108,000 h.p. output). The hydro-electric station at the foot of McNary dam, built across the Columbia River in the north-west of the United States of America, is designed to accommodate fourteen generating sets, having a total maximum output of 1,186,400kVA. The two machines under the present contract will complete this station, and they are due for commissioning before December, 1956. They will be built at the Stafford works of the English Electric Company, Ltd.

Personal and Business

MR. E. S. WADDINGTON has been appointed honorary treasurer of the Society of Engineers.

THE BRITISH ELECTRICITY AUTHORITY states that the editorial offices of *British Electricity* are now at Winsley Street, London, W.1 (telephone, Museum 4040).

MR. K. A. SPENCER, A.M.I.Chem.E., informs us that he has moved into new offices at 19, Grosvenor Place, London, S.W.1 (telephone, Sloane 4884).

MR. C. H. ELMS and Mr. E. F. STOKER have been elected directors of the National Smelting Company, Ltd. Mr. A. E. Higgs has retired from the board of the company.

THE BRITISH BROADCASTING CORPORATION announces the appointment of Mr. L. Evans as engineer-in-charge of the low-power television transmitting station near Douglas, Isle of Man.

AYLESBURY TURNED PARTS (TRUE SCREWS), Ltd., Britannia Street, Aylesbury, Bucks, states that it has been appointed agent in this country for "Helios" precision measuring instruments.

MR. A. HEALEY is retiring from his position of executive director of Dunlop Rubber Company, Ltd. He has been with the Dunlop group for thirty-eight years and was appointed a director in 1942.

BABCOCK AND WILCOX, Ltd., states that Mr. L. W. H. Rea and Mr. W. Smith have been elected directors of Edwin Danks and Co. (Oldbury), Ltd. Mr. Rea is the general manager and Mr. Smith works manager of the company.

VACUUM OIL COMPANY, Ltd., states that Mr. J. B. Bryce, Liverpool marine branch manager, is to succeed Mr. G. M. McGavin as chief marine engineer in London. Mr. R. O. Keyworth has been appointed Liverpool marine branch manager.

VAUXHALL MOTORS, Ltd., Luton, announces the resignation, on account of ill health, of Mr. C. E. King from his position as director of engineering, and from the board. Mr. King will continue to act as an engineering consultant to the company.

MR. ARTHUR HOARE, Wh.Ex., M.I.Mech.E., Overcombe, Nodgham Lane, Carisbrooke, Isle of Wight, informs us that he has relinquished his position as engineering manager of J. Samuel White and Co., Ltd., Cowes, after twenty-eight years' service.

MR. J. S. SKINNER has been appointed managing director and Mr. George McLean a director of Remington Rand, Ltd., Commonwealth House, New Oxford Street, London, W.C.1. Mr. S. D. Parker has been appointed permanent chairman of the board.

THE MERSEY DOCKS AND HARBOUR BOARD announces that Colonel J. G. B. Beazley has been re-elected chairman, and that Mr. M. Arnet Robinson, the managing director of Coast Lines, Ltd., was elected deputy chairman in succession to Major R. H. Thornton.

E. H. JONES (MACHINE TOOLS), Ltd., of Garantools House, Portslade, Sussex, announces that Mr. F. E. Wilson has been appointed to the Board of Directors. Mr. Wilson has long been associated with the company and he was recently appointed deputy to Mr. Eric Aron, the chairman and managing director of E. H. Jones (Machine Tools), Ltd., and C.V.A. Jigs, Moulds and Tools, Ltd.

Launches and Trial Trips

ARAFURA, cargo ship; built by Barclay Curle and Co., Ltd., for the Eastern and Australian Steamship Company, Ltd.; length 482ft, breadth 63ft, depth to upper deck 39ft, deadweight 10,800 tons; five cargo holds; there are eight 5-ton, eight 10-ton, one 20-ton and one 35-ton derricks; four 300kW diesel-driven generators; one set of triple expansion turbines, double reduction gearing for h.p. turbine, single reduction gearing for i.p. and l.p. turbines, propeller r.p.m. 101; two oil-fired, forced and induced draught water-tube boilers supply steam at 450 lb per square inch and 750 deg. Fah. Launched, December 21st.

CAPETAN KOSTIS, cargo ship; built by Swan, Hunter and Wigham Richardson for the Tramp Chartering Corporation of Panama; length between perpendiculars 435ft, breadth moulded 60ft, depth moulded to shelter deck 39ft; five cargo holds, derrick complement includes one to lift 30 tons and one to lift 20 tons; Swan, Hunter-Doxford oil engine, four cylinders, 700mm diameter by 2320mm combined stroke, 4800 b.h.p. at 115 r.p.m., arranged to burn boiler oil; three 150kW diesel-driven generators. Launch, December 21st.

BRITISH GUNNER, oil tanker; built by Harland and Wolff, Ltd., at the Govan shipyard, Glasgow, for the British Tanker Company, Ltd.; length between perpendiculars 490ft, breadth moulded 65ft, depth moulded 36ft, deadweight 14,000 tons; twenty-seven cargo oil tanks, two cargo oil pump-rooms, two 125kW diesel-driven generators, one 50kW steam-driven generator, Harland-B. and W., two-stroke, single-acting, opposed piston, diesel engine, six cylinders, 620mm diameter by 1870mm combined stroke, 115 r.p.m.; two single-ended multi-tubular boilers. Launch, December 22nd.

British Patent Specifications

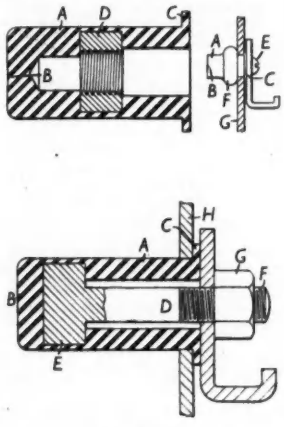
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. 8d. each.

BEARINGS AND SUPPORTS

700,379. April 16, 1951.—ANCHORING DEVICES FOR WALLS, The Rawlplug Company, Ltd., Rawlplug House, Cromwell Road, South Kensington, London, S.W.7. (*Inventor: Charles Harold Taylor.*)

One of the objects of the invention is to provide an improved anchoring device for use in cases where one face only of the wall or partition is open to the workman, and where it is essential, or desirable, that a hermetic seal shall be provided. As shown in the



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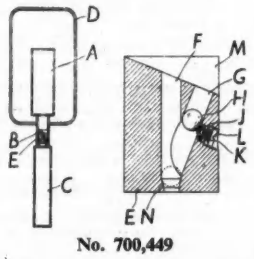
drawing, the anchoring device comprises a resiliently deformable sleeve *A* of rubber, one end *B* of which is closed and the other end open. The device has a flange *C* and a nut element *D* held within the sleeve against relative axial or rotational movement. A threaded fixing member *E* passes freely through the open end of the sleeve and screws in the nut. The nut, when engaged by the threaded fixing element, is drawn towards the open end of the anchoring device, thus causing outward buckling or deformation of the part of the sleeve between the nut and the rear surface of a wall, through a hole in which the sleeve has been inserted. When the fixing element is tightened, this deformed part of the sleeve forms a resilient washer *F* between the rear surface of the wall *G* and the nut, whereby the hole in the wall is sealed and the article to be secured to the wall is firmly held in desired position. In the alternative form shown in the lower view, the sleeve *A*, with one closed end *B* and one flanged open end *C*, is provided with a bolt *D*, the head *E* of which is secured in the sleeve adjacent the closed end. The threaded end *F* of the bolt projecting from the open end of the sleeve is engaged by a nut *G*, whereby the sleeve *A* is compressed against the inner surface of the wall *H* to deform the wall in a similar manner to that already described.—*December* 2, 1953.

VALVES

700,449. June 24, 1952.—VALVES AUTOMATICALLY OPERABLE TO PREVENT EXCESSIVE FLOW OF GASES, Philips Electrical Industries, Ltd., Spencer House, South Place, Finsbury, London, E.C.2.

The invention relates to automatic devices for preventing excessive flow of gases from one chamber to another, such as in gauge glasses of steam boilers, gas cylinders and electron-microscopes. In the



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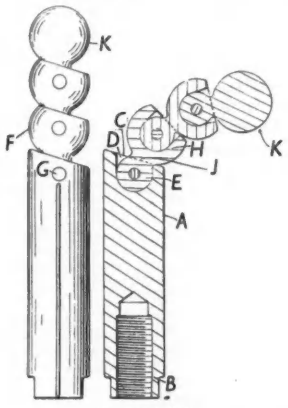
drawing a glass vessel or chamber *A* communicates by means of a main duct *B* with a metallic vessel or chamber *C*. The vessel and the duct, which are in free and direct communication with one another, are both exhausted. The vessel *A* is enclosed by an outer metallic vessel *D*, in which a pressure of, for example, about 10 atmospheres prevails. The communicating duct *B* includes a member *E*, which has two intersecting ducts *F* and *G*, which meet at an acute angle, as shown. The duct *F* has a reduced portion of which the centre line coincides with that of the main duct *B*. A ball *H* is provided in the duct *G* and is retained by means of a detent *J*, which is subject to the action of a spring *K*. This spring is compressed by an adjusting screw *L*. The member *E* also has a groove *M* into which the ducts *F* and *G* open and of which the width is equal to the diameter of the ball. The operation of the device is as follows. When the vessel *A* collapses, the gases contained in the vessel *D* and which are under high pressure flow through the ducts *F* and *G* to the interior of the vessel *C*. In this case there is a risk of glass particles being taken along. Furthermore, the vessel *C* cannot resist a high pressure. Due to the high pressure which suddenly prevails in the vessel *A* and duct *B*, the ball *H* is urged into the reduced duct, since the detent *J* is then pushed away against the action of the spring *K*. This movement of the ball is furthermore assisted in that reduced pressure occurs under the ball due to the rapid flow of the gas in the ducts. The ball finally comes to rest in the converging part of the duct *F*, which, in effect, forms a seat *N*, thus closing the direct and free communication between the vessels *A* and *C*. When it is required to return the ball *H* to the duct *G*, this may be effected by loosening the connection between vessel *C* and the main duct *B* and pushing the ball into the duct *F* by means of a pin. As soon as the ball has reached the groove *M* and is free from the duct *F*, it rolls over the inclined surface and into the duct *G*, wherein it is retained again by the detent device *J*.—*December* 2, 1953.

TOOLS AND WORKSHOP APPLIANCES

700,370. February 8, 1951.—MANDRELS FOR TUBE BENDING OPERATIONS, Hilmor, Ltd., 65, Calshot Street, London, N.1, and John Henry Hawes, of the company's address.

As the drawing shows, the mandrel comprises a cylindrical end member *A* with a tapped bore *B* at one end by which it may be joined to a rod. At the other end it has a flat surface *C* lying oblique to the axis and a further axial bore *D*. This bore receives the projection *E* of the first mandrel link *F*, which is spherical and is bored to receive a pivot pin *G* securing it to the cylindrical member. The inner end of the projection-receiving bore of the cylindrical member is hemispherical. The main portion of the link is provided by a spherical cup *H* which is joined by an intermediate stem portion *J* to the projection. The spherical cup receives the projection of a similar



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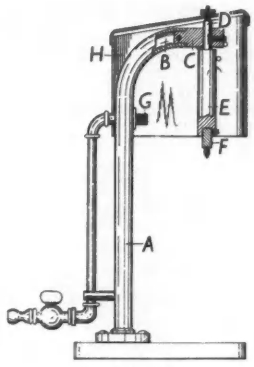
link and is bored to receive a pivot pin which connects this link with the adjacent link. The end link *K* has a solid ball in place of the spherical cups. In use, the mandrel is inserted into the tube to be bent so that the cut-away sides of the cups lie adjacent the forming tool and the tube is bent. Since the cups are cut away adjacent the forming tool, the tube can be bent about a forming tool of small radius. The contact points of the balls against the tube are close together, both on the inside and on the outside of the bend so that any kinks and flats which may be formed will be small and may be removed when the mandrel is removed without harming the tube.—*December* 2, 1953.

700,426. August 10, 1951.—BENCH TYPE SOLDERING APPARATUS, Harry Ernest Alfred Upsher, 57, Church Rise, Chessington, Surrey.

As will be seen from the drawing, the stand comprises a metal base plate to which is secured an upright tubular arm *A* bent at *B* into a horizontal position. In the end of the horizontal portion is a boss *C* having an aperture to receive a neck portion *D* of a removable depending metal heating block *E*.



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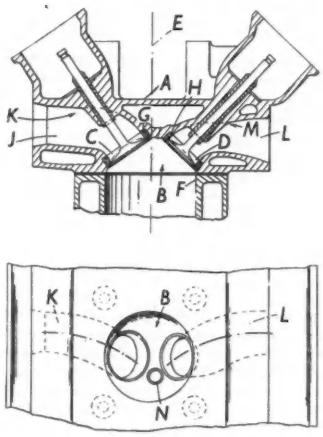
At the lower end of the block an axial bore receives a soldering bit *F*. Through the arm *B* is a gas jet *G* arranged to play a flame on to the heating block. Over the upper part of the arm is a perforated metal cover *H* which protects the operator from the flame and conserves the heat. The work is presented to the bit and solder is then fed to the appropriate position by hand or mechanical means, resulting in a great saving over the general practice of plunging the usual copper bit into a bar of solder.—*December* 2, 1953.

INTERNAL COMBUSTION ENGINES

700,364. November 20, 1950.—CYLINDER HEADS, Henry Weslake, Harbour Road, Rye Harbour, Sussex.

Referring to the drawings, the cylinder head *A* is provided with a partly spherical combustion space *B* which contains the inlet port *C* and exhaust port *D*. The ratio of the areas of these two ports is about 4 : 3·5, the inlet port being the larger. One portion of the edge of the inlet port is arranged closely adjacent the longitudinal cylinder axis *E*, while the adjacent edge of the exhaust port is disposed away from the axis and the lower edge of the exhaust port is arranged closer to the top of the cylinder proper *F* than is the corresponding edge of the inlet port. The axis of the inlet port is at an angle of about 35 deg. to the longitudinal axis of the cylinder, while the axis of the exhaust port is at an angle of about 43 deg. to the longitudinal cylinder axis. The angular separation of the adjacent edges of the two ports is about 15 deg. The gap between the two



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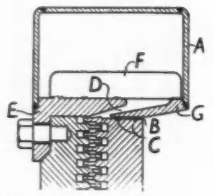
valve seats diminishes the risk of the cylinder head cracking at this location, which is the danger when the valve seats are formed by inserts as indicated at *G* and *H*. The inlet and exhaust valves are mounted in valve guides. The shape of the inlet passage *J* is roughly that of a venturi having a waist at *K*, and widening out where it meets the port. Similarly, the exhaust passage *L* is venturi shaped having its waist at *M*. As will be seen, the axis of the inlet passage is curved and where it intersects the plane of the port it is inclined to a radius of the cylinder which meets it in that plane. Similarly, the axis of the exhaust passage is curved and is inclined or oblique to a radius extending from the axis of the cylinder where that radius intersects the axis in the plane of the exhaust port in opposite sense to the angle of obliquity of the inlet passage axis, so that the axes of the two passages converge. The dispositions of the valve ports enable the sparking plug socket *N*

to be arranged comparatively close to the longitudinal axis and to the periphery of the cylinder. Modified designs are also shown in the specification.—*December 2, 1953.*

STEAM TURBINES

700,448. June 23, 1952.—RADIAL FLOW STEAM TURBINES, Svenska Turbinfabriks Aktiebolaget Ljungstrom, Finspong, Sweden. (*Inventor : Ragnar Olov Jacob Moller.*)

In a radial steam turbine, to prevent the hot steam leaking out through the labyrinth packings from reaching the wall of the turbine casing and heating it



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locally, shields are provided. These shields are attached to the stationary labyrinth discs and extend towards the steam outlet of blade system. By this means the wall of the turbine casing is protected against contact with the leakage steam which is caused to pass to and mix with the relatively cold exhaust steam of the turbine. In addition to the shields mentioned there may be provided another shield fastened to the rotary labyrinth disc and to a turbine disc of the low-pressure system. By this means a channel is obtained for conducting the leakage steam towards the flow of exhaust steam. In the arrangement shown in the drawing the steam leaking out through the labyrinth packing is collected in a housing *A* and discharges to a condenser. In order to prevent steam from leaking out through the clearance *B* sealing ribs *C* are provided, and as a further precaution against such leakage the steam when entering the housing traverses an expansion channel *D* where the pressure is reduced so as to cause a suction in the clearance *B* with relation to the expansion channel. Plates welded to members *E* and *G* of the housing *F* are for holding the members together. It is noted that the invention has proved particularly suitable in respect of bleeding turbines as shown in the specification. In such a turbine there are only comparatively small quantities of exhaust steam leaving the low-pressure system, so that the steam leaking through the labyrinth packing is more predominant and thus more detrimental, if not shielded off.—*December 2, 1953.*

Calendars and Diaries

We acknowledge receipt of calendars and/or diaries for 1954 from the undermentioned firms :

Swedish Lloyd, Gothenburg.
George Kent, Ltd., Luton, Beds.
Brook Motors, Ltd., Huddersfield.
Ruston and Hornsby, Ltd., Lincoln.
Holman Brothers, Ltd., Camborne.
A. V. Roe and Co., Ltd., Manchester.
Permali, Ltd., Bristol Road, Gloucester.
John Laing and Son, Ltd., London, S.W.1.
Butters Brothers and Co., Ltd., Glasgow.
G. and J. Weir, Ltd., Cathcart, Glasgow, S.4.
Richard Sutcliffe, Ltd., Horbury, Wakefield.
Londex, Ltd., Anerley Works, London, S.E.20.
D.P. Battery Company, Ltd., Bakewell, Derbyshire.
Crossley Brothers, Ltd., Openshaw, Manchester, 11.
Hunslet Engine Company, Ltd., Jack Lane, Leeds, 10.
Coventry Gauge and Tool Company, Ltd., Coventry.
A.C.V. Sales, Ltd., 49, Berkeley Square, London, W.1.
Mather and Platt, Ltd., Park Works, Manchester, 10.
Tube Investments, Ltd., Aston Manor, Birmingham, 6.
The Gas Council, 1, Grosvenor Place, London, S.W.1.
G. Wimpey and Co., Ltd., Hammersmith, London, W.6.
Department of Railways, New South Wales, Australia.
Davy and United Engineering Company, Ltd., Sheffield.
The Gear Grinding Company, Ltd., Shirley, Birmingham.
Bakelite, Ltd., 12–18, Grosvenor Gardens, London, S.W.1.
Davidson and Co., Ltd., Sirocco Engineering Works, Belfast.
Russell, Newbery and Co., Ltd., Essex Works, Dagenham, Essex.
Philip Henderson and Co., 1, Wine Office Court, London, E.C.4.
Edward Wood and Co., Ltd., 68, Victoria Street, London, S.W.1.
The British Oxygen Company, Ltd., Cricklewood, London, N.W.2.
The Loewy Engineering Company, Ltd., 376, Strand, London, W.C.2.
B. Elliott and Co., Ltd., Victoria Works, Willesden, London, N.W.10.
C. A. Parsons and Co., Ltd., Heaton Works, Newcastle upon Tyne, 6.
A. A. Jones and Shipman, Ltd., Narborough Road South, Leicester.
Goodwin Barsby and Co., Ltd., St. Margarets Ironworks, Leicester.
Wm. Collins, Sons and Co., Ltd., 144, Cathedral Street, Glasgow, C.4.
Bell's Asbestos and Engineering, Ltd., Bestobell Works, Slough, Bucks.
Industrial Waste Eliminators, Ltd., 7–11, Old Bailey, London, E.C.4.
Vickers-Armstrongs, Ltd., Vickers House, Broadway, London, S.W.1.
Association of Building Technicians, 5, Ashley Place, London, S.W.1.
Fischer Bearings Company, Ltd., Upper Villiers Street, Wolverhampton.
Chloride Batteries, Ltd., Exide Works, Clifton Junction, Near Manchester.
The Mond Nickel Company, Ltd., Sunderland House, Curzon Street, London, W.1.
Stewarts and Lloyds, Ltd., Brook House, Upper Brook Street, London, W.1.
Ashwell and Nesbit, Ltd., 12, Great James Street, Bedford Row, London, W.C.1.
Widnes Foundry and Engineering Company, Ltd., Lugsdale Road, Widnes, Lancs.
North British Locomotive Company, Ltd., 82, Victoria Street, London, S.W.1.
Spottiswoode, Ballantyne and Co., Ltd., 1, New Street Square, London, E.C.4.
British Vacuum Cleaner and Engineering Company, Ltd., Goblin Works, Leatherhead, Surrey.
The Telegraph Construction and Maintenance Company, Ltd., 22, Old Bond Street, London, E.C.2.
Laurence, Scott and Electromotors, Ltd., 431, Grand Buildings, Trafalgar Square, London, W.C.2.

Catalogues

Simon Carves, Ltd., Stockport.—Booklet describing "Coal Preparation Plants."

Funditor, Ltd., 3, Woodbridge Street, London, E.C.1.—Marking machine manual.

R. Cadisch and Sons, Red Lion Square, London, W.C.1.—"1954–55 Motor Catalogue."

Dowty Equipment, Ltd., Cheltenham.—Leaflet describing "Self-Sealing Dowty Coupling."

High Duty Alloys, Ltd., Slough, Bucks.—Booklet entitled "Magnuminium Technical Data."

Richardsons Westgarth (Hartlepool), Ltd., Hartlepool.—Copy of power for industry brochure.

Rubery Owen and Co., Ltd., Darlaston, South Staffs.—Booklet describing the Owen organisation.

Holset Engineering Company, Ltd., Turnbridge, Huddersfield.—Coupling and gear catalogue No. 101.

Buck and Hickman, Ltd., 2–8, Whitechapel Road, London, E.1.—Copy of 1953 general catalogue of tools and supplies.

Rockwell Machine Tool Company, Ltd., Welsh Harp, Edgware Road, London, N.W.2.—Booklet of machine tools.

F. J. Edwards, Ltd., Edwards House, 359–361, Euston Road, London, N.W.1.—Copy of Machine Tool Catalogue MT 853.

Soag Machine Tools, Ltd., Juxon Street, Lambeth, London, S.E.11.—Latest illustrated stock list of modern machine tools.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases, the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

BRITISH INSTITUTION OF RADIO ENGINEERS

Wed., Jan. 6th.—LONDON SECTION : School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, W.C.1, "Engineering Design of V.H.F. Multi-Channel Telephone Equipment." W. T. Brown, 6.30 p.m.

Thurs., Jan. 7th.—SCOTTISH SECTION : Department of Natural Philosophy, The University, Edinburgh, "Radio Astronomy," H. Seddon, 7 p.m.——N.W. SECTION : College of Technology, Manchester, "The Manchester University Computer," D. B. G. Edwards, 7 p.m.——MERSEYSIDE SECTION : Electricity Service Centre, Whitechapel, Liverpool, 1, "Interlacing Problems in Television Receivers," G. N. Patchett, 7 p.m.

CLEVELAND INSTITUTION OF ENGINEERS

Mon., Jan. 11th.—Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough, "Flame Radiation and O.H. Productivity," M. W. Thring, 6.30 p.m.

INSTITUTE OF FUEL

Tues., Jan. 12th.—Waldorf Hotel, Aldwych, London, W.C.2, "New Carbonisation Processes Under Development and Their Relation to Established Practice," D. T. Barritt and T. Kennaway, 5.30 p.m.

INSTITUTE OF METALS

Tues., Jan. 5th.—OXFORD LOCAL SECTION : Cadena Café, Cornmarket Street, Oxford, "Industrial Methods of Electroplating," G. E. Gardam, 7 p.m.

Wed., Jan. 6th.—INFORMAL DISCUSSION : The University, Edgbaston, Birmingham, "Lubricants for Metal-Working Operations in the Non-Ferrous Metal Industries," 10.30 a.m.

Thurs., Jan. 7th.—LONDON LOCAL SECTION : 4, Grosvenor Gardens, London, S.W.1, "The Rogerstone Strip Mill," F. King, 6.30 p.m.

INSTITUTE OF NAVIGATION

Fri., Jan. 15th.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, "Methods of Air and Surface Navigation," E. W. Anderson, D. H. Sadler, R. B. Michell and E. Fennessy, 5 p.m.

INSTITUTE OF PETROLEUM

Wed., Jan. 13th.—26, Portland Place, London, W.1, "The Stability and Compatibility of Fuel Oil and Diesel Fuel," C. W. G. Martin and D. R. Bailey, 5.30 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Tues., Jan. 5th.—EASTERN CENTRE : Swan Hotel, Bedford, "Vehicle Maintenance from the Aspect of Safety," A. H. Dack and J. H. Vincent, 7 p.m.

Fri., Jan. 8th.—S. WALES GROUP : S. Wales Institute of Engineers, Cardiff, "The Cost of Vehicle Maintenance," H. Rossington, 7 p.m.

Mon., Jan. 11th.—SCOTTISH CENTRE : North British Station Hotel, Edinburgh, "Lighting for Commercial Vehicles and Its Contribution to Road Safety," J. H. Nelson, 7.30 p.m.

Tues., Jan. 12th.—MIDLANDS CENTRE : Crown Inn, Birmingham, "Carburation," L. J. Spencer, 7.30 p.m.

INSTITUTE OF TRANSPORT

Mon., Jan. 11th.—ORDINARY MEETING : Jarvis Hall, 66, Portland Place, London, W.1, "Transport in the Municipal Field : Problems of the Day," W. M. Little, 5.45 p.m.

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS

Tues., Jan. 12th.—Institution of Electrical Engineers, Savoy Place, London, W.C.2, "The Control of Weeds by Tillage," F. Coleman, 2.15 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

Tues., Jan. 5th.—Geological Society Burlington House, Piccadilly, London, W.1, "Some Mechanical Handling Problems in the Chemical Industry," J. Johnston, 5.30 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., Jan. 5th.—WORKS MEETING : Great George Street, Westminster, London, S.W.1, "Swedish Underground Hydro-Electric Power Stations," J. F. Hagrup, 5.30 p.m.

Tues., Jan. 12th.—AIRPORT MEETING : Great George Street, Westminster, London, S.W.1, "The Control of Aircraft Movement at Airports," Clifford Heyes and E. J. Dickie, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Mon., Jan. 4th.—S. MIDLAND CENTRE : James Watt Memorial Institute, Great Charles Street, Birmingham, Discussion on "Technical Education of Non-National-Certificate Students," opened by J. Ashmore and D. I. Meyrick, 6 p.m.

Tues., Jan. 5th.—MEASUREMENTS SECTION : Savoy Place, Victoria Embankment, London, W.C.2, "A Scaling Unit Employing Multi-Electrode Cold-Cathode Tubes," and "A Sensitive Pulse Trigger Circuit with a Stable Threshold," K. Kandiah ; "The Development of a Neutron Spectrometer for the Intermediate Energies," F. S. Goulding, J. C. Hammerton, M. G. Kelliher, A. W. Merrison and E. R. Wiblin, 5.30 p.m.——N. MIDLAND CENTRE : British Electricity Authority, Whitehall Road, Leeds, 1, "Voltage Transformers and Current Transformers Associated with Switchgear," W. Gray and A. Wright, 6.30 p.m.

Wed., Jan. 6th.—TEES-SIDE SUB CENTRE : Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough, "Electrical Hazards" "Electrical Safety" D. A. Picken, 6.30 p.m.

Thurs., Jan. 7th.—ORDINARY MEETING : Savoy Place, London, W.C.2, Parsons Memorial Lecture, "Continuity of Electricity Supply," H. Leyburn, 5.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

Mon., Jan. 4th.—E. MIDLANDS BRANCH, GRADUATES' SECTION : College of Technology, Leicester, "Modern Methods Adopted in Power Station Installations," D. E. Challener, 7.15 p.m.——S. WALES BRANCH, GRADUATES' SECTION : Y.M.C.A. Buildings, Kingsway, Swansea, "The Utilisation and Distribution of Compressed Air in Mines," D. J. Davies, 7 p.m.

Wed., Jan. 6th.—AUTOMOBILE DIVISION : Storey's Gate, St. James's Park, London, S.W.1, "The Future Development of the National Certificate and Diploma Courses," 6.45 p.m.

Thurs., Jan. 7th.—EASTERN BRANCH, GRADUATES' SECTION : Town Hall, Luton, "Taper Roller Bearings," F. J. Wren, 7.30 p.m.——YORKSHIRE BRANCH, GRADUATES' SECTION : Technical College, Huddersfield, "Organising for 12 Off," W. R. Gaudion, 7.30 p.m.

Fri., Jan. 8th.—GENERAL MEETING : Storey's Gate, St. James's Park, London, S.W.1, "An Experimental Investigation into the Effect of Fuel Addition to the Intake Air on Performance of a Compression-Ignition Engine," W. T. Lyn ; "The Effect of Auxiliary Fuels on the Smoke-Limited Power Output of Diesel Engines," L. D. Derry, E. M. Dodds, E. B. Evans and D. Royle, 5.30 p.m.

Tues., Jan. 12th.—A.D. GENERAL MEETING : Storey's Gate, St. James's Park, London, S.W.1, "Two-Stroke Automotive Compression-Ignition Engines," Hans List, 5.30 p.m.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS

Wed., Jan. 6th.—Institution of Electrical Engineers, Savoy Place, London, W.C.2, "Telex Service," R. N. Renton, 5 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Wed., Jan. 6th.—NOTTINGHAM SECTION : Victoria Station Hotel, Milton Street, Nottingham, "The Production Engineer and His Relations," J. H. Bingham, 7 p.m.——WOLVERHAMPTON SECTION : Technical College, Wolverhampton, "Application of Hydraulic Power as an Aid to Productivity," F. B. Levetus, 7.15 p.m.

Thurs., Jan. 7th.—S. WALES AND MONMOUTHSHIRE SECTION : S. Wales Institute of Engineers, Park Place, Cardiff, "Increased Productivity by the Use of Compressed Air," C. M. P. Willcox 6.45 p.m.

Fri., Jan. 8th.—EASTERN COUNTIES SECTION : The Diocesan Hall, Tower Street, Ipswich, "The Production of Woven Artificial Silk Fabrics," E. H. Boas and N. Ray.

INSTITUTION OF SANITARY ENGINEERS

Thurs., Jan. 7th.—Caxton Hall, Westminster, London, S.W.1, Induction of E. H. Vick as President for 1954, 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS

Wed., Jan. 6th.—MIDLAND SECTION : James Watt Memorial Institute, Great Charles Street, Birmingham, Chairman's Address, "Brewing and Distilling," T. F. Luck, 7 p.m.

Fri., Jan. 8th.—Townsend House, Greycoat Place, London, S.W.1, "A Modern Vehicle Actuated Detector and Its Development," H. J. N. Riddle, 7 p.m.

Mon., Jan. 11th.—SHEFFIELD AND DISTRICT SECTION : Livesey Clegg House, Sheffield, "Clean City Air—An Engineers' Problem," James Law, 7.30 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS

Fri., Jan. 8th.—Engineers' Club, Albert Square, Manchester, "The Training of Designer-Draughtsmen," Discussion, 6.45 p.m.

REINFORCED CONCRETE ASSOCIATION

Tues., Jan. 5th.—N.W. BRANCH : College of Technology, Sackville Street, Manchester, 1, "Concreting Methods and Machinery," A. P. Lambert, 6.45 p.m.

Wed., Jan. 6th.—Liverpool Engineering Society, 24, The Temple, Dale Street, Liverpool, "Concreting Methods and Machinery," A. P. Lambert, 6.30 p.m.

ROYAL AERONAUTICAL SOCIETY

Thurs., Jan. 7th.—MAIN LECTURE : Institution of Mechanical Engineers Storey's Gate, St. James's Park, London, S.W.1, Lecture to Young People, "The Fun of Finding Out in Flying," Sir Leonard Bairstow, 6 p.m.